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ABSTRACT

This sourcebook, designed for use in grades K-12, contains energy teaching activities related to energy resources, production, distribution and use. Each activity has been classified by the editors according to the most appropriate grade level, subject matter, and energy concept involved. Subject areas are science, mathematics, social studies, language arts, and fine arts. This sourcebook draws heavily on ideas and factual materials found at the ERIC Center for Science, Mathematics, and Environmental Education. The references cited in specific activities could be useful to persons interested in obtaining more activities and ideas related to energy. Many of the activities are interdisciplinary in nature and were developed or suggested by public school teachers. (BT)

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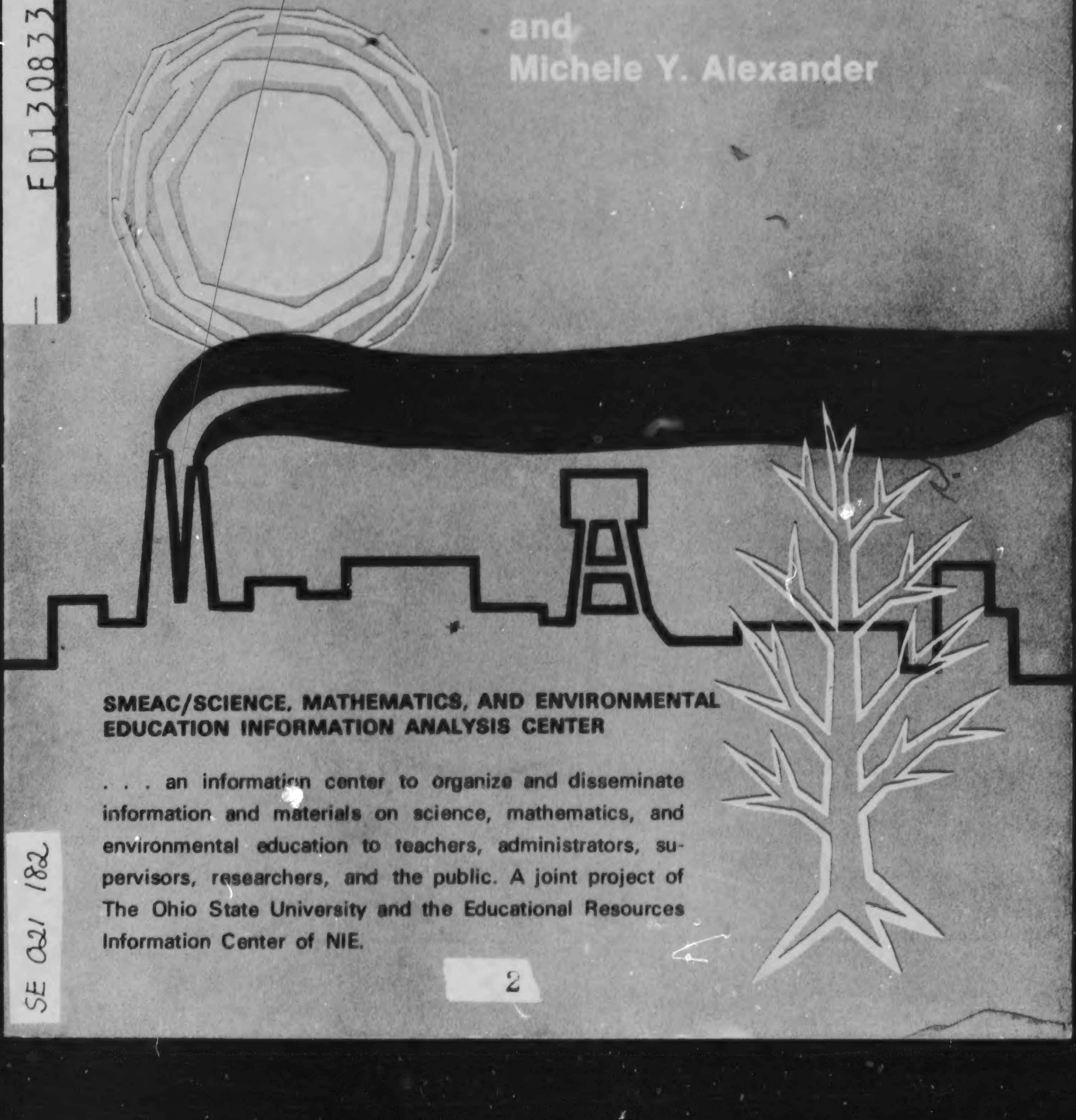
Energy Activities For the Classroom

by
Herbert L. Coon
and
Michele Y. Alexander



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SE 021 182

ERIC/SMEAC presents

ENERGY INVESTIGATIONS FOR THE CLASSROOM

Selected and edited by

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Michele Y. Alexander

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and Environmental Education
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1976

ENVIRONMENTAL EDUCATION INFORMATION REPORTS

Environmental Education Information Reports are issued to analyze and summarize information related to the teaching and learning of environmental education. It is hoped that these reviews will provide information for personnel involved in development, ideas for teachers, and indications of trends in environmental education.

Your comments and suggestions for this series are invited.

John F. Disinger
Associate Director
Environmental Education

Sponsored by the Educational Resources Information Center of the National Institute of Education and The Ohio State University.

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Preface

Energy is a matter of great concern in the United States and elsewhere around the world. The production, distribution, cost, and use of energy affects individual budgets and societal life styles in myriad ways.

The urgency of energy problems has resulted in many proposals (often contradictory) to deal with the crisis. Suggested solutions include enormous federally funded research and development projects designed to meet projected needs for energy based on growth rates of recent decades. A very different type of solution suggests that the American people move seriously toward a simpler, less energy intensive, life style.

Students in our elementary and high schools are somewhat aware of the urgency of the crisis and the diversity of solutions proposed. They understand, vaguely, that "energy" is a major factor in determining their present and future life styles. Many school systems throughout the country are attempting to capitalize on student interests in this field. They have developed bibliographies, film lists, teaching activities, and other materials judged to be helpful in promoting better study of energy related questions.

This resource booklet of energy teaching activities draws heavily on ideas and factual materials found in the ERIC Center for Science, Mathematics, and Environmental Education. The references cited in specific activities could prove to be useful to persons interested in obtaining more energy study activities and ideas. The activities suggested by public school teachers in Ohio evolved from a workshop in Energy Resources and Electrical Power Generation conducted by The Ohio State University during the summer of 1975.

Hopefully the activities included in this publication may prove to be useful to teachers in their lesson planning. We would be more pleased, however, if the publication resulted simply in more teacher and school curriculum development efforts to plan and use activities related to energy resources--energy production--energy distribution--and energy use.

Herbert L. Coon
Michele Y. Alexander

BASIC CONCEPTS FOR ENERGY STUDY

modified from Mengel, Wayne. Energy: Key to the Future, Dutchess County Board of Cooperative Educational Services, Poughkeepsie, New York, 1974, ED 092 395.

1. Energy is so basic that nothing moves or is accomplished without it.

2. Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

3. Presently, most of our energy requirements are met through using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

4. Energy, it production, use, and conservation are essential in the maintenance of our society as we know it.

5. The production and distribution of energy have environmental and economic consequences.

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GRADE LEVEL K-3

Activities

Science	4
Science-Fine Arts	1
Social Studies	2

PURPOSE: To understand the energy sources commonly used to do work.

LEVEL: K-3

SUBJECT: Science

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

ACTIVITY: Review with children the idea that work in the scientific sense is generally related to motion. Objects at rest tend to remain at rest unless force (energy) is applied to move them. Energy is often defined as the ability to do work.

Engage children in the class in lifting or pushing several of the objects in the classroom such as books, erasers, chalk, chairs, objects on the window ledges, and so forth. Help children understand that in all of these lifting and pushing activities work was being done and the energy was provided by their muscles and thus from the food they eat.

As a homework assignment ask each child to bring in 2-4 pictures from magazines or other sources that show work being done by machines or people in daily life going on around them. Analyze the pictures as a class and group them according to the energy source that is responsible for the motion (or work) being done. Organize the pictures into a wall or bulletin board display. What sources of energy seem to be most prominent in our society?

PURPOSE: To identify energy usage patterns of students.

LEVEL: K-3

SUBJECT: Science

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: Smith, Stephen M., Editor. Energy - Environment Mini-Unit Guide. NSTA, 1975, Washington, DC.

ACTIVITY:

1. Play "Simon Says" with the class doing simple motions. After a few minutes, discuss what actions they just finished. Have them draw these actions using simple stick people. Tell the class that every time they performed these actions they were using energy.
2. Using action toys in demonstration, ask students what made these toys move. (Sample answers: electricity, batteries, muscle power, etc.)
3. Lead students to observe that people, electricity, or anything else that makes things move, use energy.
4. Help students devise an inventory sheet to determine "How do you use energy?" To do this, students can make an energy picture book composed of drawings, newspaper and magazine clippings, or photographs showing the ways in which they individually use energy.

PURPOSE:	To demonstrate the heating effect of sunlight.
LEVEL:	K-3
SUBJECT:	Science
CONCEPT:	Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

ACTIVITY: Students can use a pan or bottle for this exercise. Each student group will need two identical containers and two thermometers. Since most of the students cannot read a thermometer, they can use uncalibrated ones, and, using a grease pencil, mark the initial and final readings. Interpretation can be based upon a change or rise in the column.

Students will put one container in sunlight and another, filled with the same quantity of water, in the shade. Initial temperature readings should be taken. (The teacher may want to make an actual degree reading.) After one hour students should check their containers and make a final temperature reading.

Discuss with the students what has happened. Has there been a change in the water temperature? How can you tell? Has the temperature increased, decreased, or stayed the same?

Did the sunlight have any effect on the water temperature? Did the shade have any effect on the water temperature?

Optional: Students can paint their containers with non-water-soluble flat black paint and repeat the exercise. Did the black paint have any effect on the water temperature?

Discuss the use of solar energy to heat homes.

PURPOSE: To present cognitive energy information in the form of a review game.

LEVEL: K-3
4-6

SUBJECT: Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE:* Smith, Stephen M., Editor. Energy - Environment Mini-Unit Guide, NSTA, 1975, Washington, D.C.

ACTIVITY: This review game can be modified for the very young student, as well as for the intermediate. Student will need a 16 square card. For the primary grades, drawings that represent certain energy-related terms can be drawn into each square in any order. Older students can write the words in the squares. The teacher can act as the "caller." The role of the caller is to give clues that will describe one of the energy terms. When the students hear the clue being given, they cross off that term (or picture) on their card. The first student to get four squares in a row calls Bingo. The caller then checks the student's answers. If the student is wrong, the game continues and the student is eliminated.

As a follow-up activity, students can work in small groups to devise their own game (terms and clues) and then administer it.

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*One of three very useful resource materials produced by the National Science Teachers Association Energy-Environmental Materials Project, John M. Fowler, Director. The others are (1) NSTA Energy-Environment Source Book and (2) Energy-Environment Materials Guide.

PURPOSE: To observe the energy of moving air.

LEVEL: K-3

SUBJECT: Science
Fine Arts

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: Mengel, Wayne. *Energy, Key to the Future. Teaching Techniques for the Understanding and Conservation of Energy*. Dutchess County Board of Cooperative Educational Services, Poughkeepsie, New York.

ACTIVITY: Have the students construct a simple paper pinwheel using paper, straight pin, and pencil with eraser (or other appropriate materials). Allow students to play with the pinwheels. Have them use diffeent methods of making the pinwheel move (ex.: blowing it, running with it, or placing it in front of a fan).

Guide them to observe that the faster the air moves, the faster the pinwheel turns; thus more energy is present. Also, help them observe that the pinwheel turns faster when facing directly into the force of the moving air.

This activity can be expanded upon for older students to include the concepts of efficiency and energy conversion.

PURPOSE: To understand how electricity is used in the school and how it can be saved.

LEVEL: K-3

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Energy Book, South Carolina Department of Education, Columbia, South Carolina 29201.

ACTIVITY: Invite the school custodian to come into the classroom and ask him to explain how electricity helps him to do his work in the school. Ask him to explain how his work would be different if he didn't have "electric helpers". Ask him to specify the main uses of electricity in the building. What plans have been made by him and the school principal to save electricity?

Finally ask the custodian to plan with the children as to how they can save electricity or other energy in their particular classroom. Suggest to him that they would like to have him visit their classroom every week for a few minutes to tell them how their classroom and the school is doing in its efforts to save electricity and other forms of energy.

PURPOSE: To examine how dependent we are on petroleum and electricity.

LEVEL: K-3

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Energy Book, South Carolina Department of Education, Columbus, South Carolina 29201.

ACTIVITY: Ask the children to being in pictures from magazines and/or to draw pictures of things such as houses, automobiles, boats, refrigerators, TV sets - things that they believe they would like to own or have available for their use when they are as old as their parents.

Assemble the pictures and/or drawings in a large collage. Discuss the extent to which the "good life" as they envision it depends on petroleum products, on electricity, on owning many material things that require energy to produce and operate.

Should "old folks" be saving gasoline and electricity now so that plenty will be available for use 25 years from now? Why or why not? What, if anything, can children do now to save energy for the future? Do children believe they are trying to save energy? What are they doing personally in this regard?

GRADE LEVEL 4 - 6

Activities

Science	10
Science-Mathematics	1
Science-Social Studies	4
Science-Language Arts-Social Studies-Fine Arts	1
Mathematics	1
Mathematics-Social Studies	2
Social Studies	7
Social Studies-Mathematics-Science	1
Social Studies-Language Arts	1
Social Studies-Language Arts-Science	1

PURPOSE: To show the role of solar energy in producing biomass.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: The Energy Book. South Carolina Department of Education, Columbia, South Carolina 29201.

ACTIVITY: Involve two or three children in a project to determine the gain in weight (mass) that occurs when a plant is grown from a seed.

Weigh carefully the amount of dry potting soil necessary to fill a flower pot. Moisten the soil and plant a small seed such as a lima bean or pea which has been weighed carefully on an analytic balance by a high school science student or teacher. Record the weight.

Place the flower pot on a window ledge in the classroom where it will receive available sunlight, water as needed, and permit to grow for several weeks.

Remove the plant and as many roots of the plant as possible from the soil being careful to save the soil since all soil used in the project should be dried and reweighed to ascertain the loss, if any, from the original starting material.

Dry the plant and roots thoroughly and weigh. How does the weight of the plant grown compare to the weight of the original seed? How does the weight of the plant compare with the change of weight in the soil. Where did the gain in weight come from?

How important was sunlight in this experiment? Could the dried plant be burned to produce energy? Where did that energy come from?

PURPOSE:	To understand that radioactivity occurs naturally in the earth.
LEVEL:	4-6
SUBJECT:	Science
CONCEPT:	Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.
REFERENCE:	Smith, J. M., Jr. "Natural Background Radiation and the Signification of Radiation Exposure", Sourcebook: In Support of Electric Power and the Environment, General Electric, 1973. Activity suggested by Erma Lewis, Elementary School Teacher, Columbus, Ohio.
ACTIVITY:	Obtain samples of rock containing radioactivity. Have the children bring in rock and soil samples. First get a background count of radioactivity in the room. Hold a Geiger counter (available from Civil Defense or high school science department) over these samples. Check other items in the room. Compare the activity of the Geiger counter. Which has the least number of counts? Which has the most? Place in order from least to most.

Discuss the following chart. Millirens is the unit of measure used when discussing radioactivity. Compare radioactivity found in nature with that of a nuclear power plant.

Radiation in Nature

Cosmic rays in sunshine	50 millirems per year
Food	25
Air	5
Watch dials	2
TV Sets	1-10
X-rays	50
Nuclear power plant	5

Safety factor limits based on industrial hygiene or public health considerations is 500 millirems/yr. Nuclear power plants are controlled so they emit no more than 5 millirems/yr. or 1% of 500.

Natural background radiation, depending upon where one lives, is 77-146 millirems/yr.

PURPOSE: To understand how energy is converted from one form to another.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

ACTIVITY: During the consideration of how energy is converted from one form to another arrange to take the class on a "field walk". Students, working together in groups of two or three, should be challenged to list all the energy conversions they can see or hear during a 15-20 minute walk. Ask each group to list their findings in a table such as the following:

Object Viewed or Heard	Energy Source	Conversion Product
Moving automobile	Gasoline	Motion
Moving cloud	Wind	Motion
Neon sign	Electricity	Light
Siren	Electricity	Sound

Ask each group to share its list with the class and develop on the chalkboard a master list of group findings. How many examples were reported by every group? What type of energy source predominates? What type of energy product is most common? Is electricity a "primary" or "secondary" energy source? What intermediate conversions might occur between an energy source such as gasoline in an automobile and the motion of the vehicle?

PURPOSE: To understand the multiple uses made of fossil fuels.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

ACTIVITY: At an appropriate time review with the class the fact that more than 90% of the energy used in the United States comes from fossil fuels. The fuels and percentages are approximately as follows: Oil 44%; Natural Gas 32%; Coal 18%.

Divide the class into three groups with each group responsible for doing library or reference book research to ascertain the many ways their fuel is used in American life. In addition to space heating and generating electricity the fuels are used as chemical sources for fertilizer, nylon, aspirin, dyes, etc., etc., etc.

Ask each group to prepare a large display board that shows in pictorial form many of the uses made of their particular fuel. When the group shares its display with the class they should be asked to discuss how important they believe it is to conserve their fuel for uses other than heat.

PURPOSE: To determine energy-saving bathing practices.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Energy Conservation: Experiments You Can Do, Toledo Edison Company, 1975.

ACTIVITY: By now, students have heard the energy-saving hint that asks the public to take showers and not baths. In this experiment, students can see for themselves that more energy is used in bathing. Students can do this activity as a homework assignment and share the results in class.

Have students record data while they take a bath. Fill the bathtub as usual (preferred height and temperature). Before bathing, measure the depth of the water in inches.

When it's time to bathe again, take a shower. Before you begin the shower, close the bathtub drain so that your shower water will collect in the tub. After taking your shower, measure the depth of water collected in the tub. Compare this depth with your bath water depth. Which used less hot water? By how much?

Generally, it takes an ounce of oil or a cubic foot of gas, or 1/4-kilowatt-hour of electricity to heat a gallon of water. Ask students to determine how much oil, gas, or electricity it took to heat their bath and shower water.

PURPOSE: To examine the burning qualities of several fuels.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion. hydrogen, hydro, and geothermal which must be considered and developed.

ACTIVITY: Make arrangements with a science teacher to have him or one of his students work with your class to examine the burning qualities of several different substances. While the testing can be done in any classroom, the ideal arrangement would be to take the class to a high school laboratory for the experiments.

Plan to burn several substances such as (1) candle (2) wooden splint (3) sliver of very soft coal (4) kerosene (lamp) (5) alcohol (lamp) and (6) (if possible) natural gas in a Bunsen burner. As each substance is burned the children should consider questions such as: Does it burn easily? Does it smoke a lot as it burns? Does it give off odors? Does the flame seem to be very hot?

If the Bunsen burner is available the superiority of natural gas over the other substances will be easily apparent. Without the burner the exercise will illustrate some of the problems of using coal as a fuel.

The children might attempt to develop a list of reasons why natural gas is such a good fuel.

PURPOSE: To explore alternative methods of energy production.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Ris, Thomas F., Editor. Energy and Man's Environment - Elementary Through Secondary Interdisciplinary Activity Guide, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.

ACTIVITY: Explore with the students, differences between open dumps and sanitary landfills. Discuss the problems associated with each and the potential energy and land resources involved in a landfill operation.

Visit a sanitary landfill project in the community with the students. Have the students list some of the items they see in the landfill. Then categorize those items as to those that could have been recycled, reused, or burned to produce heat.

PURPOSE: To gain insight into conservation of energy by determining which material is a better insulator.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Activity suggested by Erma Lewis, Elementary Teacher, Columbus, Ohio.

ACTIVITY: Have children bring in fruit juice cans and insulating material or use materials from a classroom "resource box".

Introduce by asking: What is insulation? Which materials are better insulators? List on chalkboard in order of insulating properties as chosen by the class. What would happen if a can were painted black?

Divide the class into groups of 3 or 4. Each group obtain a fruit juice can and insulating materials they will use.

Group 1: No insulating material

Group 2: Paint outside of can black

Group 3: Styrofoam packaging material, measure thickness

Group 4: Newspapers, same thickness as styrofoam.

Additional groups choose other insulating materials same thickness as styrofoam such as cloth, fiberglass, insulating materials from a local contractor, plastic.

Each group prepare their juice cans. Place an ice cube in each can. Place all cans either in the sun or in the shade. Check the ice cubes at fifteen minute intervals until the first ice cube is melted. Continue to check until all ice cubes are melted. Record the time it takes to melt each ice cube.

DISCUSSION

How did the black paint affect the insulating qualities of the can? Which material served as the best insulator? The poorest? List in order of insulating properties. Compare with original list. How can this knowledge be used to conserve our energy supplies? Should builders be required to insulate homes? Stores? Factories? Ask each student to check how their own homes are insulated.

PURPOSE: To understand how heated water affects aquatic life.

LEVEL: 4-6

SUBJECT: Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Nuclear Power and The Environment, American Nuclear Society. Activity suggested by Joy McDonald, Teacher, East Elementary School, Urbana, Ohio.

ACTIVITY:* Involve the students in observing and keeping a record of goldfish activity and survival when placed in a heated tank that will be heated to 20°F above room temperature over a period of two weeks. (Also use Cel. temperature readings.) Have a control tank with fish at room temperature for these two weeks. The temperature would be increased daily at rates to: 1°, 5°, 8°, 11°, 13°, 15°, 17°, 18°, 19°, 20°. Use 12 fish with different markings in order to follow through with observations during the two weeks and two weeks later.

Discuss data and observations. Show slides and drawings of the Davis Besse Power Plant and discuss the coolant tower system and the temperature of the H20 as it reaches Lake Erie from coolant tower pipeline, 15°, 8°, and 1°.

Projecting ahead what do you as a class believe will be the effects on the fish at 20°, 15°, 8°, 5°, 1°; will it have the same results on all types and sizes of fish? Do you believe some will prefer or be attracted to the warmer H2O? Do you believe some will survive? Do you believe some will not? Why or why not?

Effects of Heat on Goldfish

	ENERGY SHOWN				POSITION IN TANK					
	much	not so much	very little	none	throughout	near heater	away from heat	near bottom	near top	on top
1°										
5°										
8°										
11°										
13°										
15°										
17°										
18°										
19°										
20°										

*The activity should be terminated if it becomes obvious that the fish are being adversely affected.

PURPOSE: To present cognitive energy information in the form of a review game.

LEVEL: K-3
4-6

SUBJECT: Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE:* Smith, Stephen M., Editor. Energy - Environment Mini-Unit Guide, NSTA, 1975, Washington, D.C.

ACTIVITY: This review game can be modified for the very young student, as well as for the intermediate. Student will need a 16 square card. For the primary grades, drawings that represent certain energy-related terms can be drawn into each square in any order. Older students can write the words in the squares. The teacher can act as the "caller." The role of the caller is to give clues that will describe one of the energy terms. When the students hear the clue being given, they cross off that term (or picture) on their card. The first student to get four squares in a row calls Bingo. The caller then checks the student's answers. If the student is wrong, the game continues and the student is eliminated.

As a follow-up activity, students can work in small groups to devise their own game (terms and clues) and then administer it.

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*One of three very useful resource materials produced by the National Science Teachers Association Energy-Environmental Materials Project, John M. Fowler, Director. The others are (1) NSTA Energy-Environment Source Book and (2) Energy-Environment Materials Guide.

PURPOSE: To make a graph showing the cost of operating ten household appliances.

LEVEL: 4-6

SUBJECT: Science
Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Cost of Convenience, Columbus and Southern Ohio Electric Company. Activity suggested by Erma Lewis, Emementary Teacher, Columbus, Ohio.

ACTIVITY: Discuss mills and the construction of the graph. Each student choose 10 appliances used in their home, order these appliances from most costly to least costly and place on graph.

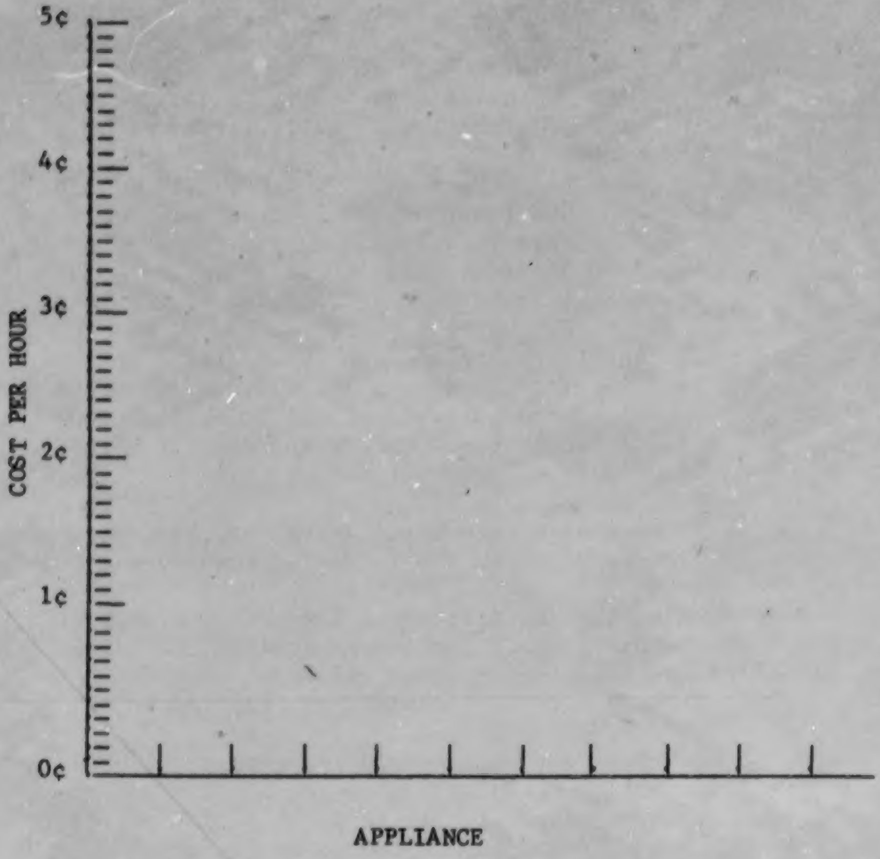


TABLE OF COST OF ELECTRICITY FOR ONE HOUR OF USE

1. Toothbrush	$ .0002	(.02 of a cent)
2. Toaster	.04	
3. Hot Water Heater:		
Tub Bath	.09-.14	
Shower	.07-.115	
Automatic Washer	.17	
Dishes by Hand	.02	
Dishwasher	.09-.14	
4. Freezer	.005	(½ cent)
5. Lights:		
Incandescent - 100 watt	.0038	
Fluorescent - 40 watt tube	.0019	
6. Record Player	.004	
7. Air Conditioning	.038	
8. Radio	.002	
9. Television:		
Black and White:		
Solid State	.002	
Tube	.006	
Color:		
Solid State	.007	
Tube	.01	
10. Range:		
Large Burner	.038	
Small Burner	.02	
Bake	.02	
Broil	.13	
11. Dishwasher	.045	
Hot Water	.14	
12. Refrigerator/Freezer - 14 cu/ft:		
Frostless	.008	
Manual	.005	
13. "Radar" Range - Microwave Oven	.05	
14. Clock	.007	

At home have each child share the chart with his family and discuss ways the family could conserve electricity.

Using the chart from the Electric Company, find the cost of operating other appliances used by the family.

Extra activities - choose at least one:

1. How many times could the toaster be used in one hour?
2. What does it cost to watch TV for one day? One week?
3. How much could be saved by washing dishes by hand instead of using the dishwasher?
4. If you take one bath a day, how much would you save by taking a shower instead of a tub bath?
5. What kind of lighting is more economical to use? Do a report to learn why it is more economical.

PURPOSE: To examine how heat can be saved in homes.

LEVEL: 4-6

SUBJECT: Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy Conservation Teaching Resource Units, Ohio Department of Education.

ACTIVITY: Divide the class into groups of five with each group representing a "family" of five: father, mother and three children. Announce to all groups that because of a very critical shortage of natural gas and fuel oil the winter heat allocation to each family is being reduced by 20 percent.

Challenge each group to prepare the best list they can of how they will deal with the problem. Ask them to think about and list what they can do to keep heat in or cold out of their homes. Specifically what can be done by the father? The mother? The children? How can they still be comfortable if they reduce the temperature in their homes?

PURPOSE: To demonstrate how solar energy can be transferred to heat energy for our homes.

LEVEL: 4-6

SUBJECT: Science
Social Studies

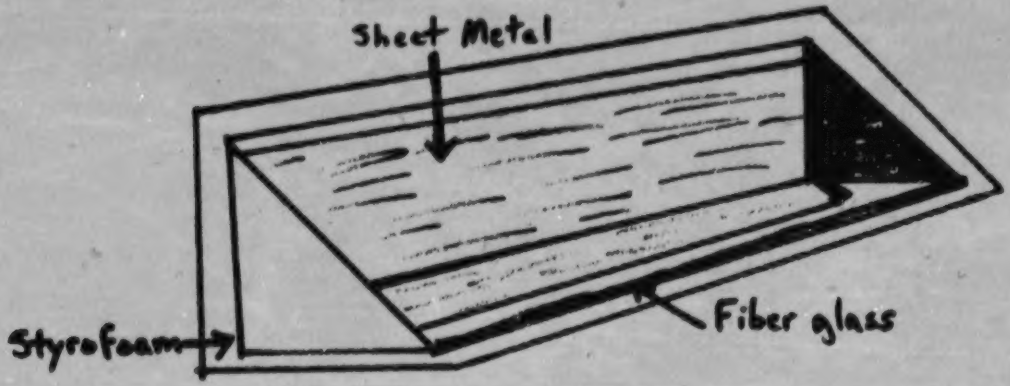
CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Daniels, Farrington. Direct Use of the Sun's Energy, Ballantine Books, New York. Science Teacher, Vol. 39, March 1972, Page 36, "Solar Energy". Activity suggested by Joy McDonald, Teacher, East Elementary School, Urbana, Ohio.

ACTIVITY:

1. After some simple experiments to show the heating power of the sun, involve the students in constructing a solar-radiation oven. Materials needed are: About 30 sq.in. of sheet metal painted one side with flat black paint; 1-5/6 sq.yd of 2 to 4-inch styrofoam or a wood frame; 1-5/6 yd of 1-inch fiberglass insulation; and a glass cover for the front. An oven thermometer and one to check water temperature would also be useful.

   Students should dry apples, heat water, and bake cup cakes in the solar oven.



2. Plan a field trip to a solar-heated home to understand how this can operate.

3. Show transparencies and slides of solar radiation collectors, cells, furnace, solar-powered steam engines, projected satellite solar-power station, and solar-heated homes. Discuss.

PURPOSE: To study individual family uses of electricity and/or natural gas.

LEVEL: 4-6
7-9

SUBJECT: Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy Conservation Teaching Resource Units, Ohio Department of Education.

ACTIVITY: Learn how to read electric and gas meters. Actual electric meters are often available, on loan, from the local electric company. Cardboard models of electric and gas meters can be made easily by students who can then practice reading a variety of meter settings as they work in pairs or groups of three.

After mastering how to read the meters ask every student to read the gas and/or electric meters in their homes at an agreed upon time (e.g. 5:00 p.m. on Wednesday). Indicate also that they will be reading the meters exactly one week later to determine how much gas and electricity they will be using in one week. Record the data for each family on a classroom chart.

After securing the base line data for one week announce an "energy saving week". Urge each child to engage his family in seeing how much they can reduce their gas and/or electricity usage before the next weekly reading will be taken. Record the data for the second week. What family saved the most? The least? What was the average saving? Children from families that saved the most can be asked to explain how they were so successful. Was it hard or easy to save energy?

Caution - This activity should be done, if possible, during a period of relatively stable temperatures such as dead of winter, early fall, or late spring. At other times, however, children can be helped to understand how changing outside temperatures affect energy use.

PURPOSE: To examine varying demands for electricity in homes.

LEVEL: 4-6
7-9

SUBJECT: Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: During a study of electricity all students should develop a clear understanding that the electricity available at the flick of a switch in our homes, schools, stores, factories, and other places cannot be stored. It must be produced as needed. During the days and hours when demand for electricity is very high the electric power companies are required to use less efficient "stand-by" capacity to produce the needed electricity thus resulting in a higher cost per KWH.

Involve the class in predicting the times when they would be using the most electricity in their homes. Try to get class agreement on the likely "ups and downs" of electrical use between 7:00 a.m. and 10:00 p.m.

Ask for student volunteers to read their home electric meters hourly on a Saturday and Sunday and bring the data to school Monday for class analysis. Do the data support their prediction?

How do they explain the high and low rates of use at different times? What suggestions can they make to spread some of peak hour demands to periods of lighter demand? Would they, personally, be willing to follow their own suggestions?

How might large communities such as cities juggle schedules to even out the electrical demand? Are the student suggestions feasible? Why or why not?

PURPOSE: To determine necessary and luxury home electrical appliances.

LEVEL: 4-6

SUBJECT: Science
Language Arts
Social Studies
Fine Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Project I-C-E, 1927 Main Street, Green Bay, Wisconsin 54301.

ACTIVITY: Have students bring to class pictures of their home and family, as well as catalogs and magazines. The students will go through the catalogs and magazines cutting out pictures of things that need electricity and putting these pictures into two groups: those that their family needs and those "extras" that they want.

Discuss with the students the idea of necessities (needs) and luxuries (wants). After they have classified their pictures, have the students choose ten electrical items that they feel are necessary to maintain their life style. (Those they can't do without.) Have the students make a collage or mobile of the ten necessities.

PURPOSE: To examine savings associated with lowering home temperatures.

LEVEL: 4-6

SUBJECT: Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Springer, George S.; Smith, Gene E. *The Energy-Saving Guidebook*, Technomic Publishing Co., 265 W. State St., Westport, Connecticut 06880.

ACTIVITY: Review with the class the information, found in sources such as the one cited above, that changing the home thermostat setting one degree will generally change heating requirements by about 3 percent. Thus reducing the setting from 70°F to 69°F will save 3 percent, changing the setting to 68°F will save 6 percent and so on.

Ask each child to (1) take this information home to mother and father, (2) try to secure from parents the cost of heating their home during the past heating season and (3) find the number of degrees (if any) the present thermostat setting differs from that of the previous year.

Suggest that the child and parent(s) calculate the savings possible by reducing the temperature from the one used years ago to a lower recommended figure such as 67 or 68°F. Is this saving worthwhile? Can the family live comfortably enough at the lower temperature.

Share findings the next day in class discussion. How many families have lowered home temperatures? How much money is saved? Do parents believe lowering home temperature is a good idea? Do students?

PURPOSE: To examine miles per gallon obtained by the classes' family cars.

LEVEL: 4-6

SUBJECT: Mathematics
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: Plan with the class to get parental cooperation in determining miles per gallon obtained by family cars during a common period of time such as Saturday morning to Saturday morning. Plan, if possible, for children to accompany parents to the filling station and record initial mileage, gallons needed to fill the tank the second time, and final mileage. Ask children (with parental help if needed) to calculate miles per gallon.

When data is brought to class the following Monday organize it into a matrix under headings such as sub-compact, compact, full size, station-wagon and/or other categories deemed appropriate.

What kinds of cars were most efficient? Why? Was this a good experiment? How could it have been improved? Whose father or mother gets the best mileage? The worst? Why? Is it a good idea for the EPA to report to the public the results of their mileage tests on new cars? What kind of car will pupils buy when they get old enough?

PURPOSE: To understand the energy savings related to using returnable bottles.

LEVEL: 4-6
7-9

SUBJECT: Mathematics
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy in Solid Waste - A Citizens Guide to Saving, Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Avenue, N.W.,Washington DC 20006. SE 019 846.

ACTIVITY: Review with the class the fact that energy can be saved by using returnable bottles instead of throw-away soft drink bottles or cans. The amount of energy saved according to the reference cited above is paraphrased as follows:

"The purchase of a six-pack of soft drinks in returnable bottles instead of no-deposit, no return containers will save the energy equivalent of 1½ pints of gasoline. The saving of 1½ pints of gasoline can take the average family car about 2½ miles. Additionally when the empty bottles are returned for the 30-cent deposit the six-pack purchase will have cost 18 cents less than for throwaways".

Involve the class in some mathematical computations. How much energy equivalent in gasoline will each family represented in the class save if they purchase one or two six-packs of returnable bottles each week for one year? How many miles of automobile travel are possible? How much money is saved? What are the total amounts for the entire class?

Since this appears to be such an easy way to save energy why do we still find so many persons buying beverages in throw away containers? What, if anything, might or should the government or people do about this matter?

PURPOSE: To involve students in planning ways to reduce use of the family car.

LEVEL: 4-6

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Citizen Action Guide to Energy Conservation, Citizens' Advisory Committee on Environment Quality, 1700 Pennsylvania Avenue, N.W., Washington, DC 20006.

ACTIVITY: Review with the class the following material from the reference cited above.

"Americans like to use their automobiles. In fact, 54 percent of all car trips in this country are less than five miles. Doesn't that seem unnecessary when frequently we could use public transportation, a bicycle, or walk? Interestingly enough, traveling on family business - going to the doctor or dentist or going shopping - accounts for 31.4 percent of all passenger car trips and averages 5.5 miles one way.

"What would happen if each family took one less trip a week - e.g. seven instead of eight - by planning ahead to combine errands and appointments so that the car did not have to be used that one time? An average family would save $74 a year. This may not be impressive enough on a family scale to some, but if every family did this we would save nationwide:

38 billion miles of driving
2.9 billion gallons of gasoline
more than 1.5 billion dollars".

Ask children to report the information quoted above to their parents and to plan one or two ways to make better scheduling of the family trips by automobile.

Have each child report his family plans to classmates. Plan to have weekly "check-up periods" to see if the better scheduling plans are succeeding.

PURPOSE: To examine energy use alternatives.

LEVEL: 4-6

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203.

ACTIVITY: Develop with the class a list of 15-20 pairs of alternative ways of doing things commonly found in our way of life, such as the following:

1. Dishwasher vs. doing dishes in sink
2. Fan vs. air conditioner
3. Power mower vs. hand mower
4. Electric razor vs. blade razor
5. Bath vs. shower
6. Gas stove vs. electric stove
7. Electric sweeper vs. broom
8. Automobile vs. bicycle.

Ask the students, working in pairs, to select one of the alternatives and to compare/contrast the amount of energy used and the benefits received from the alternative they have selected. Encourage the students to think seriously about the advantages of both alternatives. Ask each pair of students to identify to the class the alternative they prefer and then see if the class supports or does not support their choice.

PURPOSE: To compare energy sources of earlier time with those of today.

LEVEL: 4-6

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: During a study of pioneer life attention will be given to how food, clothing, and shelter were provided at that time. It should be pointed out to children that the energy sources used to do most of the work in the pioneer family unit were (1) human muscle, (2) animal power, and (3) wood.

Divide the class into three groups: food, clothing, and shelter. Ask each group to research through reading and interviews how their basic necessity was produced in pioneer times before electricity was available. Ask each group, also, to research how electricity is used today to produce the food, or clothing, or shelter we use so freely.

Ask each group to summarize its findings to the class and indicate what changes we would need to make in the way we live if we had no electricity.

PURPOSE: To develop and practice ways to save energy in the home.

LEVEL: 4-6

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy Conservation Teaching Resource Units (Primary Level), Ohio Department of Education.

ACTIVITY: Review with the class the simple but very important concept that people can save energy by not wasting things. Every time something is wasted, the energy that went into producing it is wasted. The waste of food, pencils, paper, paper towels, water, or anything else is a waste of energy.

Develop with the class a comprehensive list of things that are often wasted in their homes. The list will likely include those things cited above and others such as electricity, gas heat, cold from the refrigerator, hot water, soap, and other common products. Ask each child to make a chart of the things listed and plan to record on the chart daily for one week his personal score on wasting or saving the various things listed on the chart. Suggest that the children give themselves a plus every time they turn out a light that is not needed, use less water than usual, close the refrigerator door more quickly than usual or do something else that saves energy. Suggest also that children give themselves a minus when they become aware of something they are doing or haven't done that wastes energy.

At the end of a week of data collecting compile the data into a large chart on the chalkboard. Discuss what happened. Where did pupils save energy most often? Where was it most difficult? Did parents like the project? Were you able to change the wasteful habits of yourself? Your brothers or sisters? Your parents?

PURPOSE: To become aware of energy usage in our food system.

LEVEL: 4-6

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: Arrange to have a pizza party as a classroom activity. If possible involve parents or the school lunchroom program personnel to make the party a no-cost or very low cost activity for the pupils. Ask the persons preparing the pizza to use a great variety of ingredients: tomatoes, flour, cheese, anchovies, meat, pepperoni, etc., etc. During the party engage the children in identifying the ingredients they see or taste and list them on the chalkboard.

For each ingredient ask that two or three children research that food and report to the class on some of the energy required to make that food available for their pizza. Energy from the sun for plant growth, energy to cultivate and harvest food crops, energy to can the foods, and energy to transport the foods are examples of the energy involved that can be learned from reference sources or interviews with adults.

After the individuals or groups have reported to the class engage the entire class in considering the extent to which our food tasts and habits have resulted in heavy energy usage. How might a very serious energy shortage change our eating habits?

PURPOSE: To contrast energy usage during different periods in American history.

LEVEL: 4-6

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203.

ACTIVITY: During a study of colonial times attention will be given to the types of recreation and entertainment commonly found at that period of American history. To dramatize the difference between those early times and the present ask children to bring, if possible, from home an electrically powered toy or appliance which functions solely as a source of recreation or entertainment.

After a "fun time period" when children demonstrate their toys to their classmates engage the class in discussing the differences between toys and games commonly used in colonial times and those used today. Which cost more and why? Which type is more likely to break down or wear out and why? Which type requires more "action" from the person playing with the toy or in the game? Which type requires more thinking? Does it take energy to make and run electric toys? Is the amount of electricity or the number of batteries used large enough to really make any difference when people are worried about an energy shortage?

Ask the class to name some toys developed within recent years that might have been harmful or a waste of money and energy. How can this happen? What can they do about it?

PURPOSE: To examine the critical importance of electricity in community life.

LEVEL: 4-6

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203.

ACTIVITY: During a study of the community or "community helpers" ask students to develop a list of occupations that provide services which are essential to the survival of a community. The list will include such services as water supply, sewage treatment, food supply, fire protection, police protection, medical services, and others.

Ask students to find out, through reading or by asking adults who know, how important electricity is in the process of providing the services they have listed as essential. What would happen if electricity was not available to the persons providing those services? If we didn't have enough electricity for all these services which should be reduced first? Or would you try to save electricity someplace else? Where? How?

PURPOSE: To emphasize good (+) and bad (-) energy habits.

LEVEL: 4-6

SUBJECT: Social Studies
Mathematics
Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: *Environmental Education: Strategies for Wise Use of Energy*, North Carolina State Department of Public Instruction, Raleigh.

ACTIVITY: Through this simple board game, students will become aware of efficient energy-usage.

1. Make a game board for every 4 students.

2. Obtain dice and make place markers for each team.

3. Make positive and negative cards for energy-usage actions. Positive cards indicate efficient practices and negative cards indicate wasteful practices.

4. Roll the dice and go the number of spaces you roll. If a message is on the square, do what it indicates.

5. The winner is the person who gets to the land of Energy-Wise.

6. After game, discuss how many people have different values and attitudes toward energy and the environment.

ENERGY CARDS: Sample Cards: Forward +; Backward -.

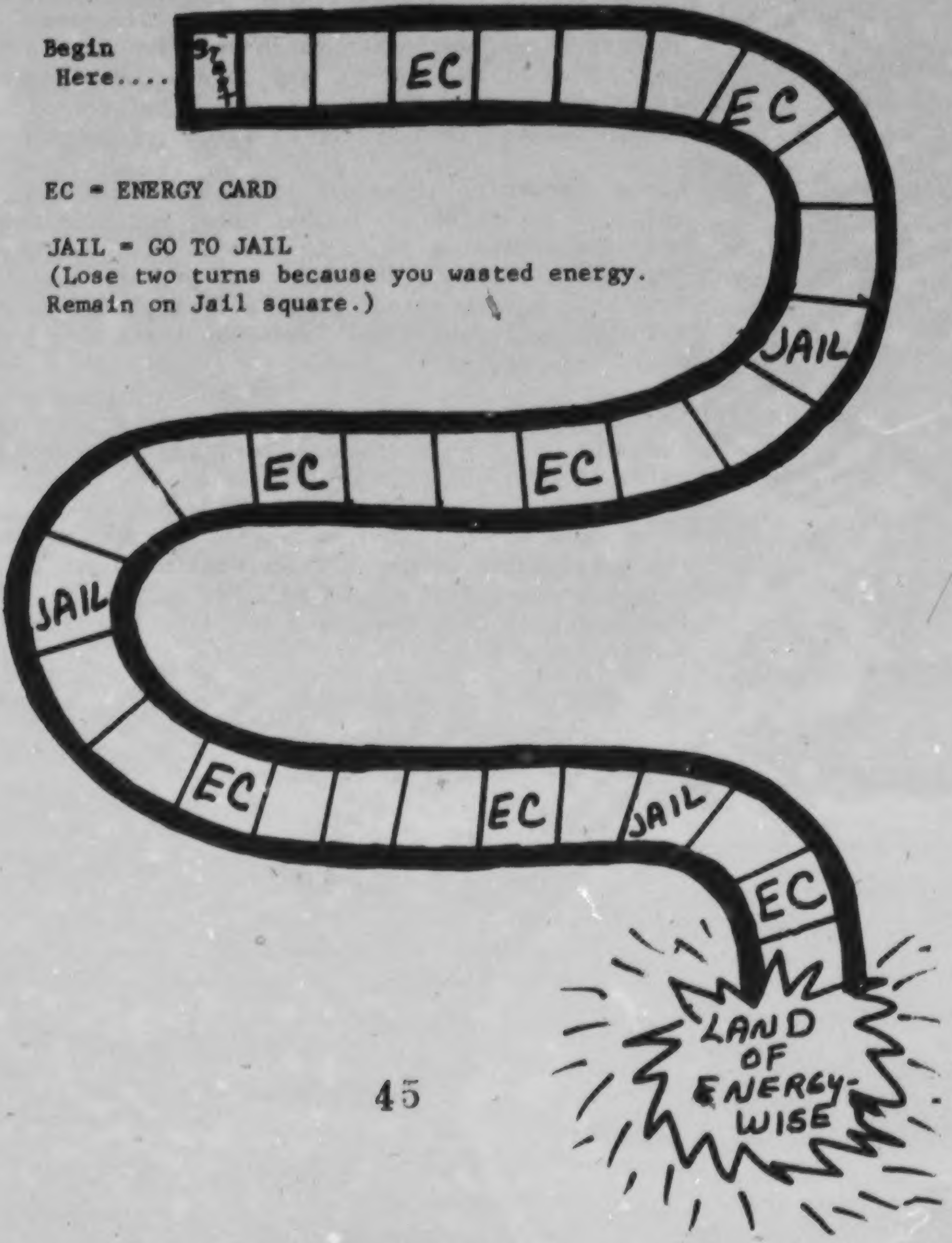
ENERGY CARDS - GROUP A: Answer Yes - move forward
Answer No - stay where you are

+2 if you turned off the light
+4 if you walked to school or rode your bike
+1 if you took a shower instead of a bath
+1 if you closed the refrigerator door
+3 if your family owns a small 4-cylinder car
+2 if your thermostat is set at 68° or lower to heat
+4 if your family has no air conditioning
+2 if you use fluorescent tubes instead of incandescent bulbs
+3 if your family has only black and white television
+1 if you turn off the radio when you leave the room

ENERGY CARDS - GROUP B: Answer Yes - move backward
Answer No - stay where you are

-3 if you use an electric toothbrush
-2 if you use an electric blanket
-4 if your house has no storm windows or storm doors
-3 if you have a dripping hot water faucet at home
-4 if your family has a big car
-4 if your family has a color TV with instant-on
-2 if you have a self-cleaning oven at home
-1 if you have an electric knife in use
-1 if there's an outside light burning during the day at home
-4 if you leave the TV playing when you leave the room

SAMPLE GAME BOARD: Begin Here....



EC = ENERGY CARD

JAIL = GO TO JAIL
(Lose two turns because you wasted energy.
Remain on Jail square.)

PURPOSE: To examine packaging practices used in American supermarkets.

LEVEL: 4-6

SUBJECT: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: In most countries of the world food purchased in grocery stores, bakeries, and meat markets is not wrapped in polyethylene or placed on styrofoam trays and then wrapped, as tends to be done in American supermarkets. The shopper brings her own shopping bag to market and places the unwrapped head of lettuce, unbagged oranges, meat wrapped only in butcher paper, and other purchases directly in her shopping bag. Much of the energy used to produce plastic films, waxed paper, styrofoam trays, and other containers in our "overpackaged" food system is saved in most countries.

After discussion along the lines suggested above ask each child to interview his mother about her willingness to use the simpler system found in most countries. What problems does she see? Does she think our present system should be kept? Is she concerned about the amount of packaging material she now throws away? Does she think the simpler system would save energy and money?

Ask each child to report to the class concerning his mother's judgment on these matters. What, if any, consensus is evident?

If mothers and children believe overpackaging is present, ask the children to write a letter stating their concern to be mailed or hand-delivered to their supermarket manager. Suggest in the letter that the class would be interested in knowing how he feels about the matter.

PURPOSE: To locate geographically our world-wide energy resources of fossil fuels.

LEVEL: 4-6

SUBJECT: Social Studies
Language Arts
Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Mengel, Wayne. *Energy, Key to the Future, Teaching Techniques for the Understanding and Conservation of Energy*, Dutchess County Board of Cooperative Educational Services, Poughkeepsie, New York.

ACTIVITY: Energy resources, such as oil, coal, and natural gas, are located in different geographic regions of the world. Have students research the known energy resources, their location and the geographic characteristics that indicate a possible fossil fuel reserve. On a map of the world, have the students locate these energy resources using different colored pins for each fuel.

Once the energy resources have been located, have the students decide which countries have the most fuel reserves and which countries have the greatest demand for those energy fuels. Discuss what problems result in this supply/demand imbalance.

GRADE LEVEL 7 - 9

Activities

Science	12
Science-Mathematics	1
Science-Social Studies	5
Science-Social Studies-Language Arts	1
Science-Home Economics	2
Mathematics-Science	4
Mathematics-Science-Social Studies	1
Mathematics-Social Studies	1
Social Studies	5
Social Studies-Science	3
Social Studies-Language Arts	4

PURPOSE: To measure heat and change of state energy.

LEVEL: 7-9

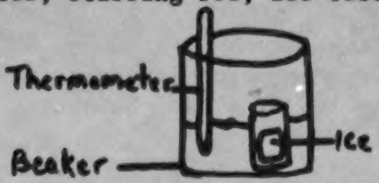
SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Actity suggested by Dorothy Bethel, Science Teacher, Franklin Junior High School, Urbana, Ohio

ACTIVITY: The student will:

1. Construct a miniature calorimeter using beakers, thermometer, stirring rod, ice cube and water.



2. Record the quantity of water and temperature of the bath.
3. Stir the water bath frequently and record the temperatures every three minutes.
4. When the ice is melted, stop, record and calculate the heat gained by the bath and lost by the ice (heat of fusion = 80 calories per one gram of ice).
5. Repeat with ice water, the same procedure and record the calories needed to lower the temperature of the ice water as the bath receives heat.
6. Discuss the concept or relate the above experience to the ice cream freezer, refrigerator, etc.
7. Trace heat transfer through a diagram of a water-cooled reactor system. (Heat of vaporization is 540 calories per gram.)
8. Discuss the value of water as a cooling agent.

PURPOSE: To determine the energy generated by a solar cell.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

ACTIVITY: Materials needed for this include a voltmeter, an ammeter and a solar cell.

On a board, connect the solar cell to the voltmeter and ammeter. Then have students take this instrument outside to experiment. Ask the students to determine the best angle of the solar cell to get maximum volt and ampere readings. Record this data.

Back in the classroom, have students determine the wattage by multiplying volts by amps. From this data, convert wattage to number of kilowatts.

How does the wattage produced by the solar cell compare with the wattage required by some household appliances? How does the number of kilowatts produced compare with a typical family's monthly consumption? Could solar cells be used to power a city? A home? How much surface area of solar cells would be required to produce the power needed for a home? What factors affect the efficiency of a solar cell?

PURPOSE:	To demonstrate the use of solar energy conversion.
LEVEL:	7-9
SUBJECT:	Science
CONCEPT:	Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.
REFERENCE:	Ris, Thomas F., Editor. Energy and Man's Environment: Elementary Through Secondary Interdisciplinary Activity Guide, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.
ACTIVITY:	Students can build a makeshift solar reflector by using an old umbrella and aluminum foil. Remove the handle of the umbrella and then line the inside with the foil. This solar reflector can be used to heat water by focusing it at the sun and then concentrating the energy on a beaker of water. Using a thermometer, make temperature readings.

1. How hot does the water temperature get?

2. How long will the water remain this hot?

3. Do you get the same results on a cloudy day? When the reflector is not pointed directly into the sun?

4. Try heating other things in your solar reflector.

5. Could the solar reflector have any applications in your everyday life?

Here the teacher can guide the students into a discussion of the potential use of solar energy to produce steam to run turbines, to heat homes, and to cook foods. A study of weather conditions and geographic locations suitable to the use of solar energy could be researched.

PURPOSE: To demonstrate the most efficient means of trapping solar energy.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Ris, Thomas F., Editor. *Energy and Man's Environment: Elementary Through Secondary Interdisciplinary Activity Guide*, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.

ACTIVITY: Students will be testing the efficiency of using solar energy to produce heat under varied conditions. Materials needed include 6 test tubes with one-hole stoppers to fit, 6 thermometers, and sheets of black, blue, red, white, and green colored paper and aluminum foil.

Students should fill each test tube with water, stopper, and insert the thermometer into the hole in the stopper. Behind each test tube, a different colored sheet of paper and the foil should be placed. The test tube set-up should be placed in direct sunlight.

Record the initial water temperature. After five minutes of sunlight exposure, read the temperature of the water again and record. Repeat this procedure for 30 minutes. What can be said about the color background and temperature change?

Repeat the experiment, this time wrapping each tube completely by the colored paper. Leave them wrapped for 30 minutes after making the first temperature reading. Are there any differences observable from the first set of data? Explain any differences.

What are the optimum conditions for producing heat from solar energy in terms of your experiment? How is this important to the production of solar cells to produce home heat? Can you see any application? Explain.

PURPOSE: To evaluate the characteristics of selected fuels.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, or geothermal which must be considered and developed.

REFERENCE: Energy Conservation Teaching Resource Units, Junior High and Middle Schools, Ohio Department of Education.

ACTIVITY: The characteristics of "good" energy resources are sometimes listed as follows:

1. High energy potential
2. Abundant supply available
3. Relatively easy to obtain
4. Relatively easy to convert the energy source into useful work
5. Extraction and use of the energy source should not have negative environmental effects or in any other way pose threats to health.

Some energy sources are high (+) in some of these characteristics but low (-) in others.

Divide the class into groups of three or four students and have them rate +, 0, or -, several fuels on the characteristics listed. Common energy resources such as coal, petroleum, natural gas and wood should be rated. It might be interesting to include other fuels seldom used in the U.S.A. such as peat, alcohol, dried cow dung and others.

Pool group judgments to determine areas of agreement or disagreement. What is the likelihood of our "running out" of the best fuels? What, if anything, can be done about it?

PURPOSE: To promote more discriminating buying of electrical appliances.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Energy Book, South Carolina Department of Education, Columbia, South Carolina 29201.

ACTIVITY: Review with the class and list on the chalkboard the major electrical appliances found in many American homes such as refrigerator, television set, stove, heater, air-conditioning unit, radio and so forth.

Ask each child to take the list home and interview his parent(s) to ascertain which, if any, of the appliances have been purchased during the past 15 years. Secure for each appliance purchased the brand name, size, and if possible, the amount of electricity required to operate. Ask parents to explain what influenced their selection of brand, size, and model for each appliance. Ask specifically whether the amount of electricity required to operate the appliance was considered before purchasing.

Record, into a large table under appropriate headings on the chalkboard, the data secured by each student. (Kind of appliance, size, brand name, etc.) What brand names are most prominent? What sizes are most common? What appliances require the most electricity? Did parents really consider the amount of electricity required to operate the various appliances when they bought them? Why did they choose the appliance they bought and not some other one? Do parents believe they will give the cost of operating an appliance more attention in future purchases? Why or why not?

PURPOSE: To observe energy transformations in the home.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Activity suggested by Dorothy Bethel, Science Teacher, Franklin Junior High School, Urbana, Ohio.

ACTIVITY: The student will:

1. Survey his home with a chart of listed items that transform energy. He will name the energy going into each item and the type of energy used in the end.
2. Use a collective procedure with the entire class and arrive at the frequencies at which various energy changes occur from their list.
3. Finalize his research with a conclusion on what energy transformations and forms are used most frequently.
4. Compare his findings with a home energy usage graph.

HOME USE AND ENERGY CHECK LIST

Name of Item Using Energy	Amount of Energy (Wattage) Required	Type of Energy Going into the Item	Type of Energy Being Used in the End	Number of Hours Used per Week	How Does It Help You?
Electric Radio					
Portable Radio					
Electric Can Opener					
Blender					
Range (stove)					
Refrigerator					
Dishwasher					
Mixer					
Hand-operated Can Opener					
Popcorn Popper					
Toaster					
Electric Skillet					
Food Grinder					
Waffle Iron					
Humidifier					
Telephone					
Lamp					
Television					
Toothbrush					
Pencil Sharpener					

HOME USE AND ENERGY CHECK LIST (Continued)

Hair Dryer					
Doorbell					
Vacuum Cleaner					
Furnace					
Water Heater					
Hand Saw					
Saber Saw					
Drill					
Sander					
Grill					
Porch Light					
Clock					
Sewing Machine					
Record Player					
Shoe Polisher					
Movie Camera					
Iron					
Candles					
Broom					
Washer					
Dryer					
Ceiling Light					
Fan					
Deepfreeze					
Mop					

HOME USE AND ENERGY CHECK LIST (Continued)

Vaporizer					
Electric Razor					
Fireplace					
Toys					
Flashlight					
Car					
Grinder					
Bell					
Knife					
Electric Blanket					
Hot Plate					
Garbage Disposal					
Bun Warmer					
Adding Machine					

PURPOSE: To examine changing patterns of energy use.

LEVEL: 7-9

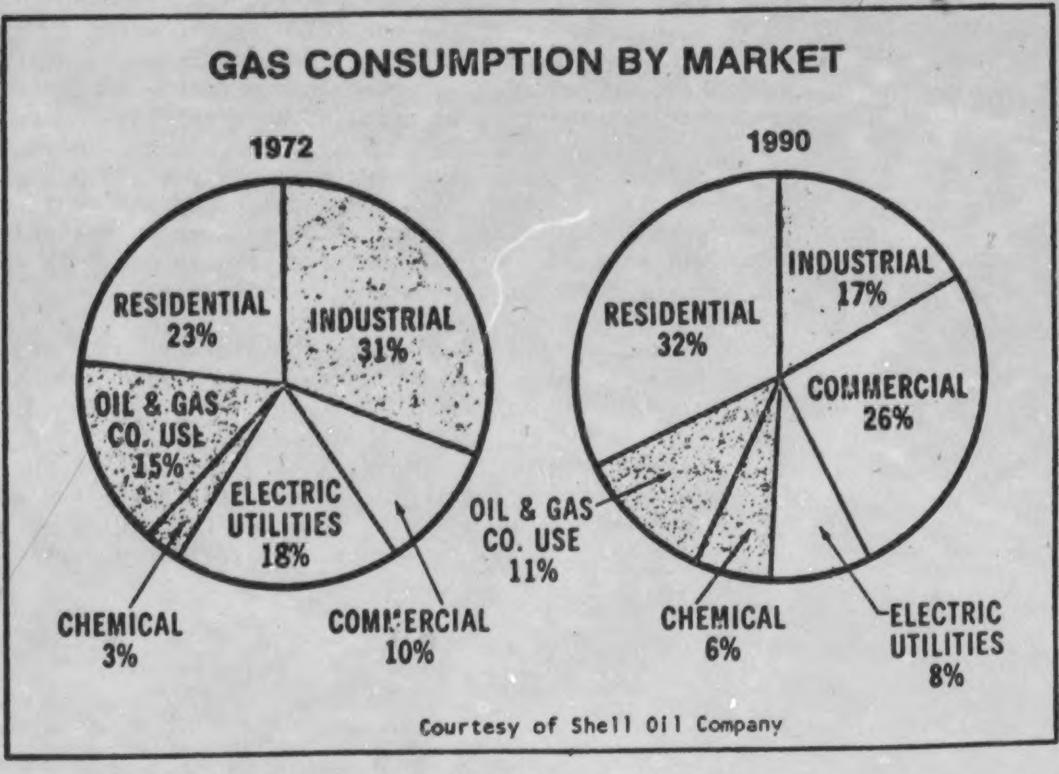
SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

ACTIVITY: Present to the class the pattern of natural gas use in the U.S.A. in 1972 and the projected uses of this source of energy in 1990 as reported below by the Shell Oil Company.

Ask for volunteers or divide the class into six groups and assign the homework or library research task of finding as many specific examples as they can of how natural gas is used in the residential, industrial, commercial, electric utility, chemical and oil and gas markets.

Share the findings in a subsequent class meeting. Try to analyze why some markets will be increasing and others decreasing their use of natural gas between now and 1990. What energy resources will be substituted in the industrial and electric utilities markets for diminishing supplies of natural gas?



Courtesy of Shell Oil Company

PURPOSE: To study the conversion of plant materials into coal.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Activity suggested by Michele Alexander and John Neth, Science Teachers, Groveport-Madison High School, Groveport, Ohio

ACTIVITY: Have available in class the following materials:

ferns
slides or diagrams of tree ferns
sand, peat moss, coal
10 gallon aquarium
slides or charts of geologic time

1. Distribute to the students, samples of ferns, peat, and coal. Show students geologic time charts and describe the physical condition of the earth during the coal-forming processes.

2. Fill a 10 gallon aquarium with tap water. Add enough peat moss to make a one-inch layer. Allow one week to elapse. What is the condition of the water now? (Include pH, odor, turbidity, decomposition of peat, etc.) Have any changes occurred in the peat? Suggest reasons for the changes, or explain why changes did not occur.

   Sift moderately fine sand over the peat to a depth of one inch. After the sand settles, add an equal depth of peat. Repeat the process for as long as desired, or until several successive layers have formed. Is coal still being formed today naturally? Explain.

3. Students should then go to the library and research the formation of coal, the types of coal, and the locations of coal deposits in this state.

4. Using topographical maps, locate the coal-producing areas in your state (or in the United States). Find cross-sections of the area and locate a coal vein. Would the cost of extracting the coal be feasible and practical?

PURPOSE: To examine energy usage in the public water supply.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

ACTIVITY: Secure a topographic map(s) of the area that includes the city water filtration-pumping station and the residences of the students in the class. Involve the students in learning how to read elevation levels on a topographic map and ask each student to determine the difference in elevation between the pumping plant and his home. (Homes will almost always be higher than the pumping plant.)

Ask the student to obtain from his parents a record of the amount of water used in the home during the past three or six months. The weight of water used can be calculated since one cubic foot weighs 62.5 pounds. The height the water was lifted is known from the elevation differences found on the topographic map(s).

Since work can be measured in ft/lbs the elevation difference times weight of water used equals the minimum work done to deliver water to the family. Review other factors that would increase this amount (e.g., friction, height of water supply standpipe, and others.)

Compare results obtained for each household. Which one required more energy to have its water delivered? Why? Is wasting water also wasting energy? What are some very obvious ways to save water and thus electricity?

PURPOSE: To use a steam engine model to power a wheel.

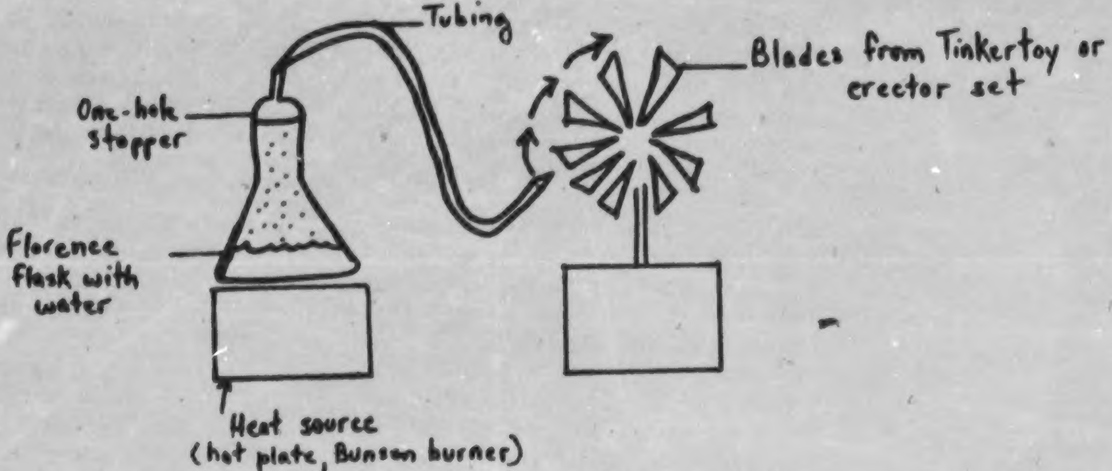
LEVEL: 7-9

SUBJECT: Science

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: Ris, Thomas F., Editor. Energy and Man's Environment: Elementary Through Secondary Interdisciplinary Activity Guide. Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.

ACTIVITY: Using the following materials and design, students can assemble a model steam engine.


Tubing
Blades from Tinkertoy or erector set
One-hole stopper
Florence flask with water
Heat source (hot plate, Bunsen burner)

Teachers can guide the students into a discussion of energy production and conversion. The following sample questions could be discussed:

1. What other heat sources (fuels) could have been used to boil the water?
2. How could you improve the design of this powerplant to increase efficiency? Try your idea.
3. How can the turning wheel be made to do work?
4. What is a turbine? How does it work?
5. What are some ways in which this model steam engine converts or can convert energy?

PURPOSE: To design a miniature power plant.

LEVEL: 7-9

SUBJECT: Science

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

REFERENCE: Kestler, Ronald. "Super Spool: An Experiment in Powerplant Design", Science Activities, May/June 1974.

ACTIVITY: Students will need the following materials to build their powerplants - rubberbands, an empty wooden thread spool, two wooden matches or two pieces of plastic straw, a 1/4-inch thick wax washer cut from a piece of candle, and a small nail.

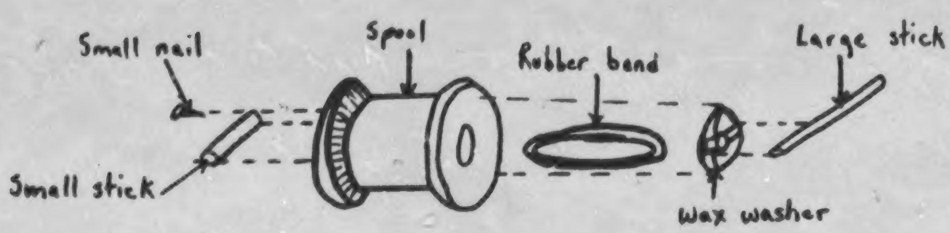
Directions to construct this power plant are as follows:

Step 1: Drive the nail into the spool, about 1/8 inch from the hole.

Step 2: Cut a 1/4-inch round slab of wax. The end of a candle can be used for this. Bore a hole in the center and notch one side.

Step 3: Thread the rubberband through the wax washer and the hole in the spool; loop it over the large stick at the end with the wax washer and over the small stick at the end with the nail.

Step 4: Wind the large stick about 10 to 20 turns, place on a flat surface, and release. The spool should move forward at a slow even rate.



Discussions concerning energy production and work done can be generated while working with these miniature powerplants. Some of the following questions could be discussed while working with these spools:

1. Why does the spool move?

2. What is its source of energy?

3. What is its rate of speed in:
    a) in/min
    b) ft/hr
    c) mm/sec
    d) cm/min
    e) m/hr

4. What can be done to increase the speed of the spool?

5. How steep (in degrees) an inclined plane will the spool climb?

6. How much of a load will the spool pull?

7. Make improvements on the basic design that will increase power and efficiency.

Introduce the idea of doing work and discuss the methods in which work is done. Relate this miniature power plant to the production of energy at real-life power plants.

PURPOSE: To provide students with an understanding of (1) how the amount of electricity used in the home is measured, and (2) the differences in energy requirements and operation costs of various household appliances.

LEVEL: 7-9

SUBJECT: Science
Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Living With Electricity, Columbus & Southern Ohio Electricity Company, 1967. Activity suggested by James M. Richmond, Doctoral Student in Science Education, Ohio State University, Columbus, Ohio.

ACTIVITY: Define the terms needed to understand the measurement of electricity consumption in the home (watt, kilowatt, kilowatt hour). From an electric company bill determine the average cost of a kilowatt-hour (KWH) for your area. Have students examine the table of "Average Wattage of Electrical Appliances", and then compute what it costs in their own homes to:

1. Leave a 100-watt light bulb burning for 6 hours
2. Use the vacuum cleaner for 2 hours
3. Use all burners of the oven and range for 3 hours
4. Use a dishwasher for 1 hour every day for 30 days
5. Run an electric clock for 1 year.

A variety of other simple calculations (appropriate for the class) should be devised to illustrate the relative cost of household appliances.

DISCUSSION

Have students list all the electrical appliances in their homes. What appliances consume the most energy? What ones consume the least? Are these appliances necessary or simply luxuries? What can we do to conserve energy and decrease household costs?

ACTIVITIES TO BE COMPLETED AT HOME

1. Check the wattage of the light bulbs and fluorescent bulbs in your house, and estimate the number of minutes or hours that they are used each day. Determine the cost of lighting your home for one evening, one month, and one year.

2. If previous electric bills are available, construct a graph to show the monthly cost of electricity consumed in your home over the past 12 months. Is there a significant variation in the cost per month? Which months are most expensive? Why?

3. Record the reading on your electric meter at the same time each day for one week (or one month). Plot a cumulative graph (and histogram) to illustrate your electricity consumption (KWH) over the period of time. Is more electricity consumed on some days than on others? Why?

AVERAGE WATTAGE OF ELECTRICAL APPLIANCES

1000 watts = 1 kilowatt

Appliance	*Average Wattage*
Bottle Warmer	400
Broiler	1325
Clothes Dryer	4600
Clock	2
Coffeemaker (Automatic)	830
Cooker (Egg)	520
Dehumidifier	230
Dishwasher (With heat unit)	1155
Dishwasher (No heat unit)	290
Disposal (Only)	330
Fan, Attic	370
Fan, Desk	70
Fan, Furnace	225
Fan, Ventilating	85
Floor Polisher	240
Germicidal Lamp	20
Grill	770
Hair Dryer	235

Appliance	*Average Wattage*
Heat Lamp (Infrared)	250
Heater, Radiant	1095
Hot Plate	1140
Mixer, Food	130
Oil Burner	245
Percolator	490
Radio	90
Radio-Phonograph	100
Razor	15
Sewing Machine	75
Stoker	300
Television	220
Toaster	1000
Vacuum Cleaner (Tank type)	375
Vibrator	45
Waffle Iron	855
Washer	280
Water Pump	265

These appliances are usually controlled by thermostats which permit the flow of electricity for intermittent periods only.

Electric Blanket	180
Heating Pad	55
Food Freezer (8 cu. ft.)	125
Iron	1,000
Ironer	1,500

Range	12,000*
Refrigerator	205
Room Cooler (Window type)	400
Roaster	1,300
Water Heater (66 gallons)	3250

****This includes total wattage of all the burners and oven of the range.***

PURPOSE: To become more aware of energy wasteful habits.

LEVEL: 7-9

SUBJECT: Science
Social Studies

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Energy in Solid Waste - A Citizens Guide to Saving. Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Ave., N.W., Washington, DC 20006.

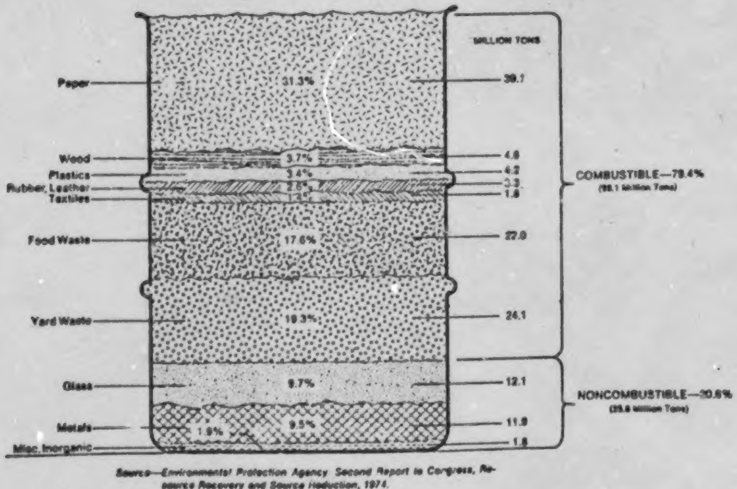
ACTIVITY: Review with the class the general principle that energy is required to make all of the substances we throw away in our trash cans. Develop on the chalkboard with input from students a list of the substances commonly thrown into trash cans such as paper, food wastes, glass containers, plastic wrapping materials, and others. Ask students to "guess" what substances comprise the major portions of solid waste found in the "National Trash Can".

Present, with use of an overhead projector, the figure below that shows the amount of various substances comprising the national trash can in 1971. Compare the data shown with their guesses.

Involve students in speculating whether the contents of the trash can have been changing since 1971. Why or why not? Ask each student to list on paper several things he and/or his family can do to reduce waste in two or three of the categories. Discuss individual responses in an effort to reach class consensus.

National Trash Can

(Annual Municipal Solid Waste – 1971)



Source—Environmental Protection Agency Second Report to Congress, Resource Recovery and Source Reduction, 1974.

PURPOSE: To examine the role of mass transit in fuel conservation.

LEVEL: 7-9

SUBJECT: Science
Social Studies

CONCEPT: Energy its production. use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Ris, Thomas F., Editor. Energy and Man's Environment: Elementary Through Secondary Interdisciplinary Activity Guide, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121.

ACTIVITY: Discuss with students the types of public transportation or mass transit systems available to U.S. cities (bus, subway, train). It has been suggested that thru greater use of these, private citizens would use less fuel.

Suppose this were put into action.

List the fuels that would be saved. What, if any, new fuels would be used [illegible]

What jobs might be lost?

What new jobs would be created for these new transportation systems?

Economically, would it be beneficial to adopt a mass transit system in place of the present auto-dominated one?

Conservationally, would there be a sufficient reduction in fuel usage and pollution to warrant this change-over?

PURPOSE: To relate electrical energy needs to maintenance of present life styles.

LEVEL: 7-9

SUBJECT: Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Activity suggested by M. K. Waggoner, Science Teacher, Fairland High School, Proctorville, Ohio.

ACTIVITY: (It will be evident that this activity works best just prior to a 5 or more day vacation when the student is not required to be in school or other public institution.)

On the school day prior to the beginning of this activity ask each student to survey his/her home and property after school and list every item that requires alternating current in order to function.

On the first day of this activity make a composite list on the classroom blackboard of all the types of items named by the students.

Divide the students into small groups of 3-5 and have each group use the composite list to make the following sublists:

1. Items "absolutely necessary"

2. Items "difficult to do without"

3. Items "you could live without"

4. Items "that are nice to have"

5. Items "entirely luxurious"

Student groups will differ somewhat on where they sublist various items and these differences should be discussed to help them see their own hierarchies of needs.

On the classroom blackboard, divide the items in the composite list into the 5 sublists based on general concensus of the class. Be sure each student now has these items so listed.

Now ask for student volunteers who will take part in the following experiment during their impending 5 (or more) day vacation. Volunteers will eliminate from their daily lives as many items as practicable according to the following form:

Day 1. Eliminate all items in sublist 5;

Day 2. Eliminate all items in sublists 5 and 4;

Day 3. Eliminate all items in sublists 5, 4, and 3;

Day 4. Eliminate all items in sublists 5, 4, 3, and 2;

Day 5. Eliminate all items in sublists 5, 4, 3, 2, and 1.

Ask students to keep daily diaries during the course of the experiment of their impressions and discuss these as a group when school resumes.

Discussion should help students see what changes, if any, they would willingly make in their life styles to conserve energy; what changes may be reasonably imposed on them during an energy shortage and what they would consider unreasonable hardships during such a shortage. This discussion may also lead into another activity on alternate energy sources, should the students not desire any reduction in energy consumption.

PURPOSE: To examine varying demands for electricity in homes.

LEVEL: 4-6
7-9

SUBJECT: Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: During a study of electricity all students should develop a clear understanding that the electricity available at the flick of a switch in our homes, schools, stores, factories, and other places cannot be stored. It must be produced as needed. During the days and hours when demand for electricity is very high the electric power companies are required to use less efficient "stand-by" capacity to produce the needed electricity thus resulting in a higher cost per KWH.

Involve the class in predicting the times when they would be using the most electricity in their homes. Try to get class agreement on the likely "ups and downs" of electrical use between 7:00 a.m. and 10:00 p.m.

Ask for student volunteers to read their home electric meters hourly on a Saturday and Sunday and bring the data to school Monday for class analysis. Do the data support their prediction?

How do they explain the high and low rates of use at different times? What suggestions can they make to spread some of peak hour demands to periods of lighter demand? Would they, personally, be willing to follow their own suggestions?

How might large communities such as cities juggle schedules to even out the electrical demand? Are the student suggestions feasible? Why or why not?

PURPOSE: To study individual family uses of electricity and/or natural gas.

LEVEL: 4-6
7-9

SUBJECT: Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy Conservation Teaching Resource Units, Ohio Department of Education.

ACTIVITY: Learn how to read electric and gas meters. Actual electric meters are often available, on loan, from the local electric company. Cardboard models of electric and gas meters can be made easily by students who can then practice reading a variety of meter settings as they work in pairs or groups of three.

After mastering how to read the meters ask every student to read the gas and/or electric meters in their homes at an agreed upon time (e.g. 5:00 p.m. on Wednesday). Indicate also that they will be reading the meters exactly one week later to determine how much gas and electricity they will be using in one week. Record the data for each family on a classroom chart.

After securing the base line data for one week announce an "energy saving week". Urge each child to engage his family in seeing how much they can reduce their gas and/or electricity usage before the next weekly reading will be taken. Record the data for the second week. What family saved the most? The least? What was the average saving? Children from families that saved the most can be asked to explain how they were so successful. Was it hard or easy to save energy?

Caution - This activity should be done, if possible, during a period of relatively stable temperatures such as dead of winter, early fall, or late spring. At other times, however, children can be helped to understand how changing outside temperatures affect energy use.

PURPOSE: To examine energy usage in various modes of transportation.

LEVEL: 7-9

SUBJECT: Science
Social Studies
Language Arts

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

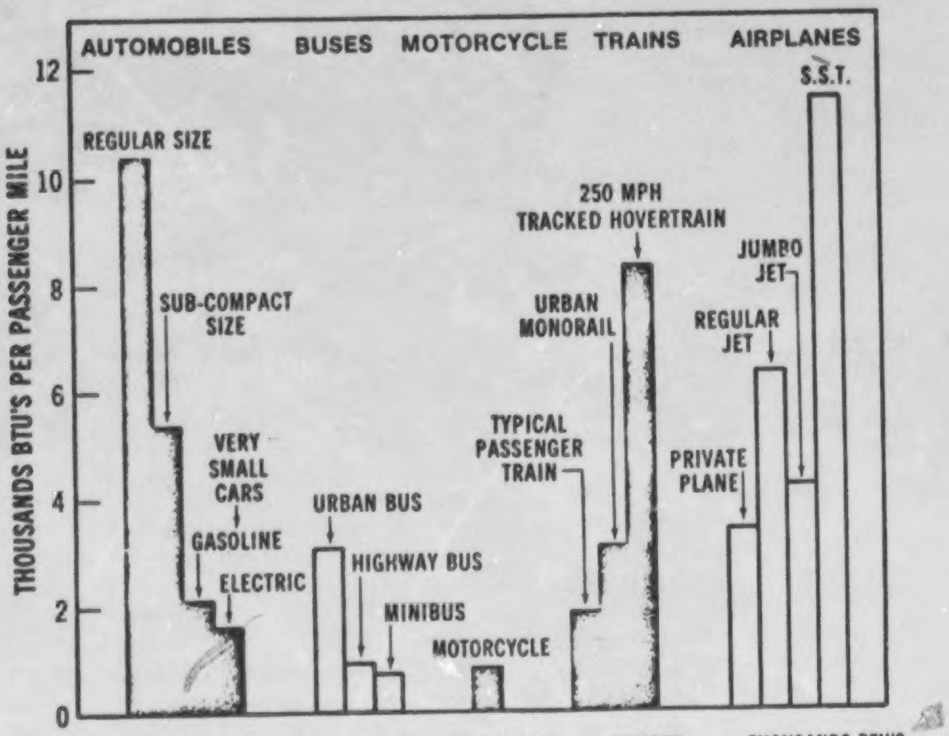
REFERENCE: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203

ACTIVITY: Present to the class the graphed data shown below entitled "Transportation Energy Consumption of Various Modes".

Divide the class into four groups entitled (1) automobiles, (2) buses, (3) trains, and (4) airplanes. Assign each group the responsibility to examine carefully the data concerning the efficiency of various vehicles within their mode of transportation. Each group should also compare the efficiency of their mode with the other three.

Each group should select a spokesman or two who will explain, as clearly as possible, why certain vehicles in their type of transportation are more energy consumptive than others. The spokesman should also report and defend the group decision as to whether "their type" of transportation should increase or decrease in the years ahead.

TRANSPORTATION ENERGY CONSUMPTION OF VARIOUS MODES



	MODE	PASSENGER MILES PER GALLON	NUMBER PASSENGERS	THOUSANDS BTU'S PER PASSENGER MILE
Autos:	Regular Size	12	1.3	10.4
	Sub-compact	23	1.3	5.4
	Very Small (gasoline)	59	1.3	2.1
	Very Small (electric)	78	1.3	1.6
*Buses:	Urban bus	40	12	3.1
	Highway bus	140	22	0.9
	Minibus	175	7	0.7
*Motorcycle:	(2 HP)	160	1	0.8
*Trains:	Passenger train	65	300	1.9
	250 mph Tracked Hovertrain	15	48	8.3
	Urban Monorail	40	20	3.1
*Planes:	Private plane	37	3	3.4
	Regular jet (DC-8)	20	80	6.3
	Jumbo jet (B-747)	30	200	4.2
	S.S.T. (Mach 2.7, U.S.)	11	150	11.4

***Source:** *Rice, Richard A., 1972, "Energy Efficiencies of the Transport Systems;" a paper presented before the Society of Automotive Engineers at the International Automotive Engineering Congress, Detroit, Michigan, January, 1973.*

PURPOSE: To illustrate the need for conserving energy.

LEVEL: 7-9

SUBJECT: Science
Home Economics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: Shortages in home heating fuels and the high cost of electrical energy generation have prompted utility companies, as well as the public, to look into energy conserving methods to help heat the home efficiently.

Have the students prepare a checklist of conserving projects for their homes. Then have the individual students survey their homes to see if the practices are in effect there. Students can bring this information back to the classroom and discuss the problems that prevail. After this large group discussion, have the students take back their findings to their parents.

Topics for discussion should include amount of fuel wasted, effect on heating bill, and ways to alleviate the problems.

Sample Checklist:

	Yes	No
Storm Windows		
Storm Doors		
Insulation		
Heat Off in Unused Rooms		
Weatherstripping		

PURPOSE: To determine the most efficient and economical means of cooking meals.

LEVEL: 7-9

SUBJECT: Science
Home Economics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: In a time when everyone is concerned with energy consumption and conservation, this activity is designed to show students how some practices start in the home.

Have students choose a recipe for a roast or a cake. Have some prepare the food in an electric oven, a microwave oven, a toasteroven, and a crockpot. Determine the wattage of each appliance by reading the labels on each. Next convert this to kilowatts. Have students check the recipes for the time needed to bake or cook in each appliance. Multiply this time by the number of kilowatts. This converts the information into kilowatt hours. To determine the cost of using this much energy, multiply to kilowatt hours by the local cost per kilowatt hour.

What is the cheapest appliance to operate? Which appliance uses the least energy? Is there any difference in the quality of food cooked? In which appliance did the food cook best? How can you conserve energy in cooking?

PURPOSE: To study the world's suppiy of depletable natural resources.

LEVEL: 7-9

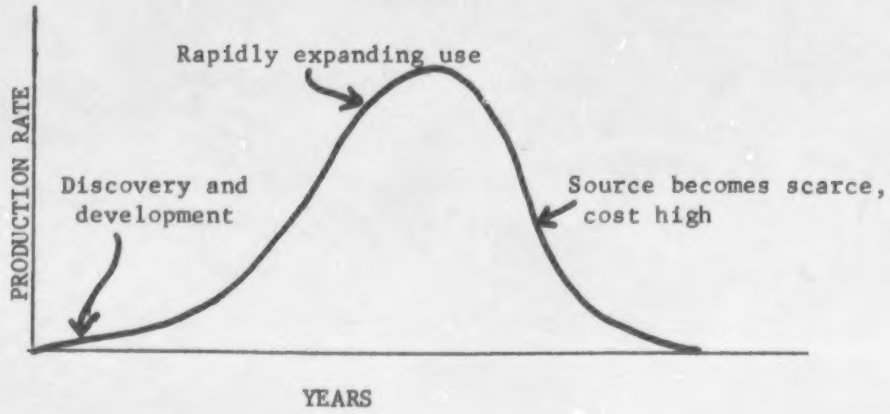
SUBJECT: Mathematics
Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

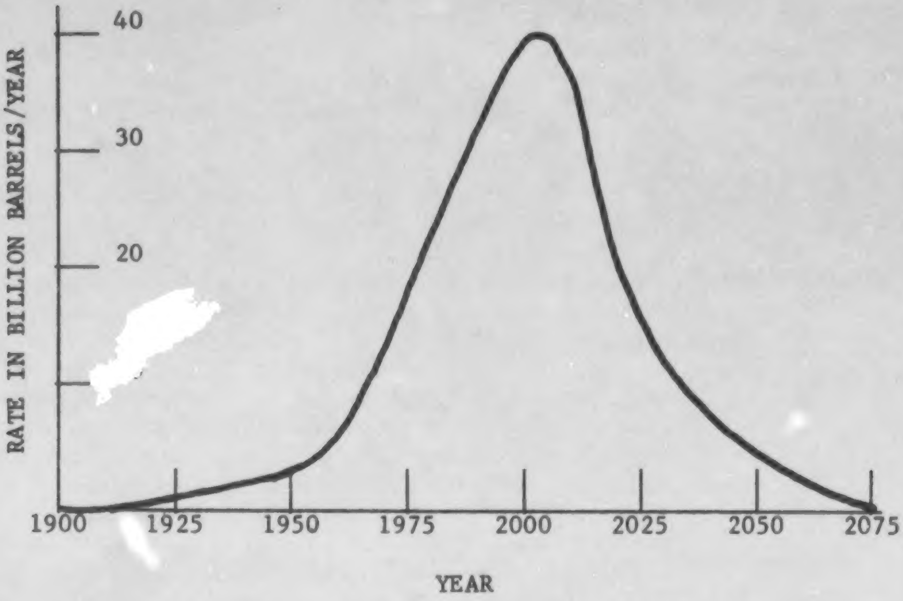
REFERENCE: Activity suggested by Penelope McCartney, Science Teacher, Pettisville High School, Pettisville, Ohio.

ACTIVITY: Energy is that quality that allows or causes change, force, work, movement or heat. The results of energy can be measured and its effects felt. Many people falsely assume that energy will be available forever. The world's supply of natural resources, especially those which go into the creation of energy, are not limitless. Energy producing resources are being used at an ever increasing rate by the affluent nations of the world. Until recently, very little thought or attention has been given to what will happen when the raw materials needed to produce energy become scarce and ultimately depleted. The United States has only a small fraction of the earth's population, but consumes more than one-third of the earth's annual output of natural resources to produce the goods and services represented by our present standard of living.

The graph below represents the life span of a depletable resource.



The following graph represents an optimistic view of the life span of the world's oil resources.



After studying both graphs answer the following questions.

1. When did the discovery of the use of oil for producing energy occur?
2. What is happening today in regard to the use of oil as an energy producing source?
3. How many years do we have left before our natural resource above is depleted?
4. From the available literature obtain data adequate to construct a graph showing the life span of another energy producing natural resource such as natural gas, uranium, or coal.

**Do you feel that it is fair for a country the size of the United States to use perhaps as much as thirty times the amount of unrenewable resources per person as another smaller underdeveloped country? Give reasons to support your answer.

PURPOSE: To determine how much it costs per month to operate various home electrical appliances.

LEVEL: 7-9

SUBJECT: Mathematics
Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Activity suggested by Michael G. Mashchak, Science Teacher, Lehman High School, Canton, Ohio.

ACTIVITY: Students can calculate the cost of operating appliances in their homes when the following information is available: the appliance wattage, the number of hours it operates, and the cost of electricity.

Review with the class the definitions of the following basic electrical terms: volt, amp, watt, kilowatt, and kilowatt-hour (KWH). Then give the class some sample problems using the following formulas:

$$\text{Watts} = \text{Amps} \times \text{Volts}$$

$$\text{KWH} = \frac{\text{Amps} \times \text{Volts} \times \text{Hours of use}}{1000 \text{ watts}}$$

$$\text{KWH} = \frac{\text{Wattage} \times \text{Hours}}{1000 \text{ watts}}$$

Ask the students to choose five home appliances that can be monitored for one month. Request that they locate (serial plate) or calculate (amps x volts) the wattage for each test appliance and record this information on their data chart. Also, have each student record the hours of use per day for each of the experiment's test appliances.

Suggest that an index card be taped to each test appliance so that any member of the family can record its "on" time.

While collecting data calculate the KWH (wattage x "on" time) used per day for each test appliance.

Call the local electric utility to find the average cost per KWH for all residential customers. It is possible to get a more accurate figure by dividing the amount of your electric bill by the number of KWH used during the billing month.

Operation for the test appliances can be determined by multiplying the KWH by the cost per KWH.

Example: A styling hair dryer uses 330 watts and its "on" time is 4 hours per month. How many KWH's are used, and what does it cost to operate?

$$\text{KWH} = \frac{\text{wattage x hours}}{\text{1000 watts}}$$

$$\text{KWH} = \frac{330 \times 4}{1000} = \frac{1320}{1000} = 1.32 \text{ KWH}$$

Now to find the cost of operation, multiply the KWH by the cost per KWH ($.038).

$$1.32 \times .038 = 0.05016$$

The hair dryer would cost about $.05 to operate for one month.

The data collected during this activity will give each student an idea how much it actually costs to operate a particular appliance for one month. In addition, each student could use his electric bill (total KWH's used) to determine what percentage of electrical power was required to operate that appliance.

PURPOSE: To examine world wide distribution and use of natural gas.

LEVEL: 7-9

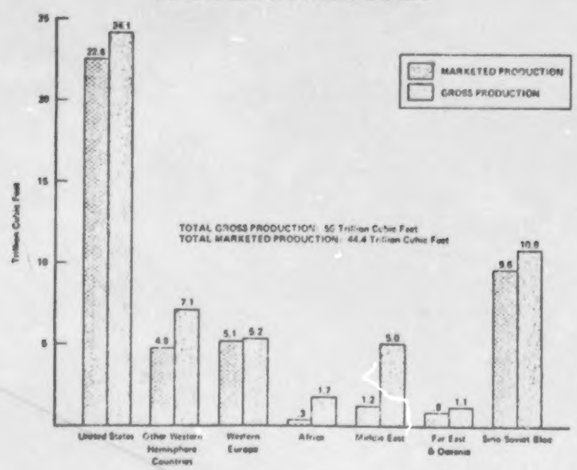
SUBJECT: Mathematics
Science

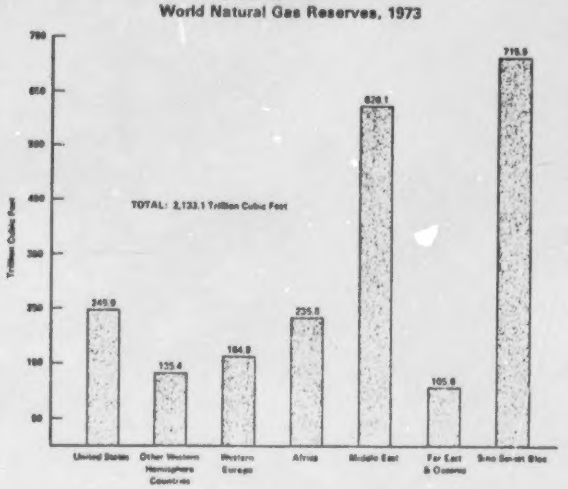
CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Energy Facts II, Science Policy Research Division, Congressional Research Service, Library of Congress, 1975, U.S. Government Printing Office, Washington, DC 20402.

ACTIVITY: Review with the class the data shown below concerning natural gas production throughout the world in 1973. Review also the data shown concerning natural gas reserves throughout the world in the same year.

Ask students to calculate the number of years of assured gas supply for each geographic region on the basis of rate of production and known reserves in 1973. What countries or regions appear likely to exhaust their supplies first? What regions are in the best position? What sources of supply are most promising for regions that may need to buy this fuel? Is it possible to ship natural gas across thousands of miles of ocean as we do petroleum? What makes gas shipped in this manner so expensive?


(Source 17)
World Natural Gas Production, 1973


(Source 17)
World Natural Gas Reserves, 1973

PURPOSE: To calculate energy equivalents of household trash.

LEVEL: 7-9

SUBJECT: Mathematics
Science

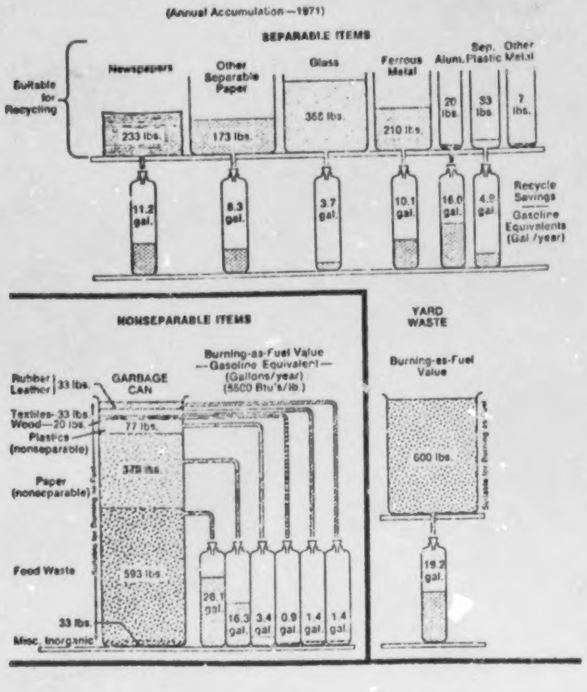
CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Energy In Solid Waste - A Citizens Guide to Saving. Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Ave., N.W., Washington, DC 20006. SE 019 846.

ACTIVITY: Review with the class the general principle that energy is required to make all of the substances we throw away in our trash cans. Review also the principle that recycling materials generally requires less energy than making new products from virgin materials. Indicate that energy savings can be calculated in KWH of electricity, BTU's, gasoline equivalents, and in other units.

Present, with use of an overhead projector or duplicated hand-out, the figure below that shows gasoline equivalents of various substances thrown into trash cans annually by the average American household.

What substances are most prominent? What surprises, if any, are noted? How much potential saving of energy (gasoline equivalents) could be obtained from the number of families represented in the classroom? By the number of families in your county or city? Why aren't we moving more rapidly to save energy by recycling? Would anyone be hurt by such moves?



Household Refuse Collection Center

PURPOSE: To acquaint the student with the method of reading an electric meter and interpreting an electric service billing.

LEVEL: 7-9

SUBJECT: Mathematics
Science
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Living with Electricity, Columbus and Southern Ohio Electric Company. Activity suggested by Yvonne A. Mather, Science Teacher, Canfield High School, Canfield, Ohio.

ACTIVITY: The teacher will distribute copies of the accompanying material to all students and, with the aid of a master copy on the overhead projector, guide them through the steps in reading the electric meter. Be sure that the students understand the procedure by changing the positions of the dials and asking for new readings. (A large cardboard type of chart containing meters and movable dials could be constructed by one of the students and used for individual practice.)

Following the same basic procedure, the teacher guides the student through a reading and explanation of the indicated items on the electric service bill, giving special attention to the figures which indicate the kilowatt hours used.

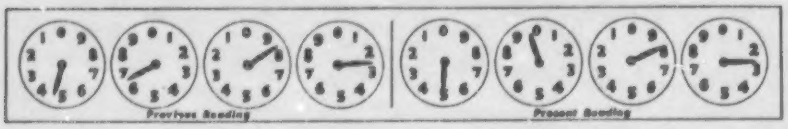
Several costs of operation of appliances in the home can be worked out using the rate chart included in this activity. It may be a good idea to check your local power company to determine if the rates are substantially different from those included here.

Follow Up: Students record daily kilowatt readings (at the same time each day) for one month, recording these data in a simple journal which also includes some observations about the temperature, appliance use, and other pertinent factors which might affect the amount of use of appliances.

LATEST RATING SCALES - JUNE 1975

1st 20 Kilowatt Hours	$ .021
20-100 KWH	.045
100-200 KWH	.039
200-750 KWH	.039
750-1350 KWH	$ .031
1350-7800 KWH	.0285

DO-IT-YOURSELF PROJECTS



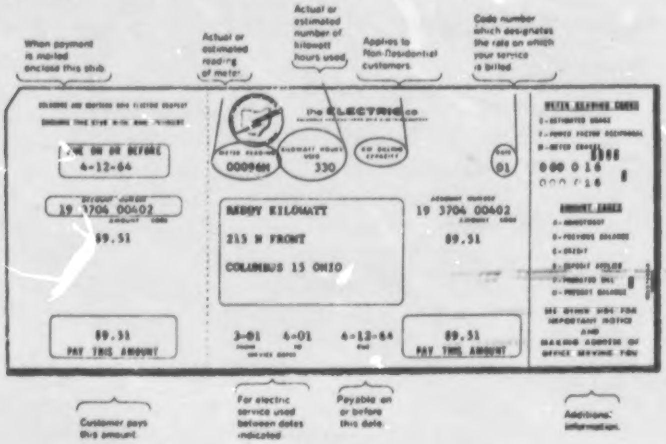
How to Read a Meter

To read an electric meter, stand directly in front of dials. Read dials from left to right. Some of the dials move in opposite directions from each other, but regardless of that, always read the smaller figure when the hands are between two numbers. For instance, in the left box above, the figures read 4682.

If the hand of the first dial appears to be directly over a number, read the next dial to determine whether or not the hand has passed zero. If it hasn't reached zero, use the next lower number on the first dial. The reading on the dials in the right box should be 4982.

The figures on the dials represent kilowatt-hours which signify the number of kilowatts flowing through your meter multiplied by the length of time.

How to Determine Amount of Electricity Used


When payment is mailed enclose this stub
Actual or estimated reading of meter
Actual or estimated number of kilowatt hours used
Applies to Non-Residential customers
Code number which designates the rate on which your service is billed
Customer pays this amount
For electric service used between dates indicated
Payable on or before this date
Additional information

the ELECTRIC co

4-12-64

19 3704 00402

$9.51

000964

330

01

RADDY KILOWATT
215 N FRONT
COLUMBUS 15 OHIO

19 3704 00402

$9.51

$9.51
PAY THIS AMOUNT

3-01 4-01 4-12-64

$9.51
PAY THIS AMOUNT

The reproduction of the above bill is similar to the one which comes to your home monthly. The figure circled at the top of the bill is the present meter reading. If you subtract the corresponding reading in the previous bill from the present reading you get the number of kilowatt-hours (330) of electricity used between the present and previous readings.

PURPOSE: To understand the energy savings related to using returnable bottles.

LEVEL: 4-6
7-9

SUBJECT: Mathematics
Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy in Solid Waste - A Citizens Guide to Saving, Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Avenue, N.W.,Washington DC 20006. SE 019 846.

ACTIVITY: Review with the class the fact that energy can be saved by using returnable bottles instead of throw-away soft drink bottles or cans. The amount of energy saved according to the reference cited above is paraphrased as follows:

"The purchase of a six-pack of soft drinks in returnable bottles instead of no-deposit, no return containers will save the energy equivalent of 1½ pints of gasoline. The saving of 1½ pints of gasoline can take the average family car about 2½ miles. Additionally when the empty bottles are returned for the 30-cent deposit the six-pack purchase will have cost 18 cents less than for throwaways".

Involve the class in some mathematical computations. How much energy equivalent in gasoline will each family represented in the class save if they purchase one or two six-packs of returnable bottles each week for one year? How many miles of automobile travel are possible? How much money is saved? What are the total amounts for the entire class?

Since this appears to be such an easy way to save energy why do we still find so many persons buying beverages in throw away containers? What, if anything, might or should the government or people do about this matter?

PURPOSE: To develop and apply criteria for allocating limited energy supplies.

LEVEL: 7-9

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Energy Book, South Carolina Department of Education, Columbia, South Carolina.

ACTIVITY: It is quite conceivable in the years ahead that a local community might find its energy supply (gas, gasoline, electricity) curtailed significantly. Under these circumstances which energy consumers should be given highest priority?

Divide the class into groups of three or four students. Ask each group to develop criteria they deem appropriate to apply in making priority decisions for energy usage.

Ask each group, also, to identify major and/or critical energy users in the local community such as homes, schools, industries, hospitals, power plants, police, firemen, water systems and so forth.

Finally ask each group to apply their criteria to their identified energy users and designate priorities. Determine concensus and areas of disagreement as each group reports to the class.

What options other than the possibility of arbitrary priority allocations are available to the American people?

PROBLEM: To examine the importance of energy in changing life styles.

LEVEL: 7-9

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: As a homework assignment ask each student to interview at least one person who can recall from personal experience what life was like in the U.S.A. forty or more years ago. Ask the older person to identify several of the most significant changes that have occurred regarding the "life style" of the American people.

Develop on the chalkboard a composite listing of all significant changes cited by the persons interviewed. The list will likely include more automobiles, better highways, scheduled airlines, automatic heat, television, supermarkets, frozen foods, longer vacations, fast food operations, and many, many others.

Assign to pairs of students the task of thinking seriously about one of the significant changes and reporting their conclusions to the class. What kind of energy was (is) used to produced the change in life style? Was (is) that form of energy plentiful in the U.S.A.? Is that energy supply assured for the next forty years? Have the changes in life style been "good"?

PURPOSE: To examine conflicting demands for limited energy supplies.

LEVEL: 7-9

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Energy Book, South Carolina Department of Education, Columbia, South Carolina 29201.

ACTIVITY: Divide the class into interest groups representing several of the major segments of energy users or groups concerned about the diminishing supply and rising cost of energy such as: manufacturers, workers, oil and gas companies, truckers, coal mine owners, local and state government, foresters, and farmers.

Ask each group to discuss the importance of the group they represent in the life of the community or state or nation. Ask them also to decide whether the percentage of energy they represent of total energy use in the community should be increased, remain the same, or be decreased if supplies become more limited and some type of allocation system must be developed.

After each group has presented its views to the class ask each student to vote on what he believes to be the perferred allocation of energy to each segment of the community under conditions of greatly reduced supply. What change, if any, would this produce in community and/or personal life styles?

PURPOSE: To become more aware of energy costs in family budgets.

LEVEL: 7-9

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Citizen Action Guide to Energy Conservation, Citizens' Advisory Committee on Environmental Quality, 1700 Pennsylvania Avenue, N.W., Washington, DC 20006.

ACTIVITY: Make available to every child the "Annual Household Energy Budget" shown below. Ask that each child review, as homework with his parent(s), the data shown in the table. Specifically parents should be asked to indicate where their energy expenditures exceed or fall below the dollar values indicated. Ask parents, also, to estimate how much energy costs have increased since mid-1973. (More than 50%.)

Organize the data returned by children into a large chart on the chalkboard to determine where the families represented in the class use more or less energy than the average family. What factors are responsible for the differences that may appear? Are parents worried about the increasing cost of energy? What are they doing to save energy costs in the family budget?

A Family Energy Budget

Other than when you pay the monthly utility bill or calculate your income tax, have you ever stopped to think what your total energy costs are? The figures and charts on the preceding pages show the energy budget for the Nation. Here is an annual energy budget for an average American family. It shows energy end use and the form of energy consumed by that use. It shows the amount of energy consumed in two ways: by the standard energy measurement, the Btu, and its equivalent in gallons of gasoline, so that it will be more meaningful to you. It will also show you that an average family spends about $743 a year for energy—about 7 percent of its average income.

ANNUAL HOUSEHOLD ENERGY BUDGET IN MID-1973

ENERGY END USE	FORM OF ENERGY	ENERGY PER YEAR		DOLLAR VALUE d) ($)	EQUIVALENT AMOUNT OF GASOLINE (Gallons)
		Percent	Million Btu		
Automobile	Gasoline	28.2	113.9	344.83	911
Space Heating	Natural Gas, Oil, & Electricity	27.8	112.1	165.89	897
Major Appliances	Electricity	2.7	11.0	78.20	88
Water Heating	Natural Gas, Oil, & Electricity	6.2	25.1	48.25	201
a) Air Conditioning	Electricity	1.6	6.6	45.78	53
Lighting & Other Electrical	Electricity	1.4	5.7	30.07	46
Cooking	Natural Gas & Electricity	1.9	7.5	18.27	60
b) Miscellaneous Household & Recreation	Gasoline	0.6	2.5	7.57	20
Public Transportation (Inter-city; Non-Business Trips)	Jet Fuel, Diesel, & Electricity	1.7	6.8	—	54
(Intra-city Trips)	Diesel & Electricity	0.1	0.6	—	5
Waste Heat, Electricity Power Generation	Coal, Oil, Natural Gas, & Nuclear	21.8	87.9	c)	704
Refinery Loss in Gasoline Production	Petroleum	5.9	24.0	c)	182
Totals		100%	403.7 Million Btu	$743.46	3,231 gallons of gasoline

NOTES
a) For households so equipped.
b) Lawn Mowers, Boats, Motorcycles, Etc.
c) Included in Price of Product.
d) Based on a weighted average of fuels supplying each item.

PURPOSE: To examine the importance of energy in a specific vocational field.

LEVEL: 7-9
10-12

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Energy Book, South Carolina Department of Education, Columbia, South Carolina.

ACTIVITY: During a social studies unit on choosing a vocation or at some other appropriate time ask students, working alone or in pairs, to develop a notebook on an occupation of their choice.

Specify that in addition to availability of work in the vocational field, salary potential, education required, special training needed and so forth special attention be given to the energy requirements associated with their vocational choice. How would their vocation be affected if special forms of energy such as natural gas would be curtailed drastically? What would be the effect if gasoline prices doubled? If electricity became much more expensive?

Ask that students consider also the ecological impact of their occupation on local community, state, nation, and the world. Is the occupation likely to have a positive, neutral, or negative effect?

PURPOSE: To understand the energy needed to operate various kinds of machines.

LEVEL: 7-9

SUBJECT: Social Studies
Science

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

ACTIVITY: Tools (or machines) have evolved from the simple stone axe of primitive man to the complex computer or jet airplane of today. Power (energy) to operate man's growing collection of machines started with his own muscle and subsequently came predominantly from animals, wind, water, wood, coal, petroleum, natural gas, and nuclear energy.

Divide the class into groups of four or five pupils and ask each group to list (from reference books, interviews, or their previous knowledge) several machines that are or have been powered by each of the listed energy sources. Some or all groups may wish to develop a mural or series of murals depicting their findings.

In follow-up discussion give attention to the question of when people started to make very complicated machines. Why weren't they made before that time? What kind(s) of energy appear to be associated with very big or very complicated machines? Why? Do pupils think our lives might be getting too complicated with too many very complex machines?

PURPOSE: To understand that public energy consumption is generally based on socio-cultural factors.

LEVEL: 7-9

SUBJECT: Social Studies
Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Activity suggested by R. J. Zitto, Science Teacher, Kenton High School, Kenton, Ohio.

ACTIVITY: Locate on a city map the numbers and types of street lamps (can do for a small area and extrapolate). Calculate the costs for operating these lights over a year's time. Compare this cost of operation to cost for heating an average home.

Have students find out from the city planners why the street lights were placed there and the reasons for the number and pattern. They might also find the crime statistics for the area. Any discussion on the crime rates must also be associated with other socio-economic problems of the area.

DISCUSSION

1. Could the layout (pattern) of lighting be changed and the numbers reduced?

2. Should the lights be on all night?

3. Do they really serve as a crime deterrent?

4. Wouldn't carrying flashlights serve the same purpose?

PURPOSE: To understand more fully the pattern of energy usage in the United States.

LEVEL: 7-9
10-12

SUBJECT: Social Studies
Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

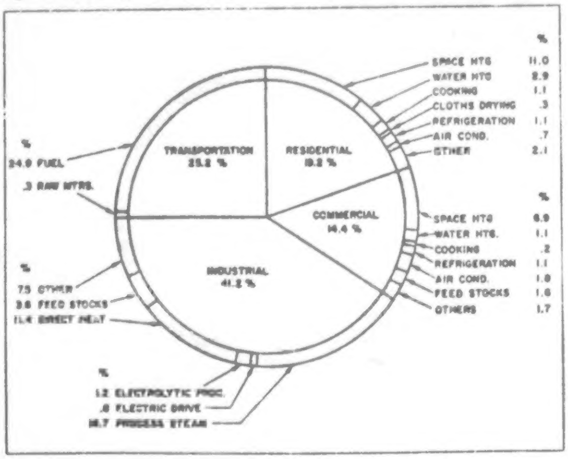
REFERENCE: Fowler, J. M.; Mervine, K. E. Energy and the Environment, ESSO Education Foundation.

ACTIVITY: Present to the class the figure shown below. Ask students working in groups of two or three to (1) identify out of their own personal experience or previous knowledge the energy sources (oil, gas, coal, etc.) used for various purposes shown such as space heating, water heating, cooking, and so forth, and (2) give two examples of how energy could be saved in each of the use categories shown.

Each group should present its conclusions in chart form to a reporting committee of four students who will analyze the data and report conclusions the following day regarding residential, commercial, industrial, and transportation energy consumption. (The person reporting on industrial uses should augment what comes from the class by contacting an industrial, chemical, or mechanical engineer for ideas and examples pertinent to that area.)

In summary discussion raise questions about what each class member can do that can make a difference in each of the major categories.

Figure 4. U.S. energy consumption 1971 (total 60.5 x 10^{15} BTUs).



PURPOSE:	To determine if energy shortages have influenced advertising.
LEVEL:	7-9
SUBJECT:	Social Studies Language Arts
CONCEPT:	Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: Review with the class an example or two of ways people have been motivated to use more energy in the past. Advertising extolling the advantages of frost-free refrigerators might be an appropriate example. Urging people to buy larger automobiles with automatic transmissions and air conditioning may be a better example.

Ask a small group of students to examine, in a good library, several issues of popular magazines such as Life, Time, Newsweek, or National Geographic that were published 5-10 years ago. What advertisements urged people to buy things that used large amounts of energy? Get specific examples.

Ask the group to examine, also, several very recent issues of some of the same magazines. Do advertisements now urge people to buy things that use smaller amounts of energy? Get specific examples.

Ask the group to report their findings to the class and provide leadership in a total class discussion of questions such as: Is the campaign to get people to use less energy really visible? Is it likely to succeed? Why or why not?

PURPOSE: To survey the extent to which the community is conserving energy.

LEVEL: 7-9

SUBJECT: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203.

ACTIVITY: Review with the class the concern and pleadings from the President of the United States and other high government officials that the country curtail energy usage.

Develop with the class a list of places in the community that use substantial amounts of electricity. The list would probably include homes, supermarkets, schools, service stations, public buildings, restaurants, motels, hotels, department stores, churches, and possibly manufacturing companies.

Ask students to work in groups of two or three to observe their homes and one of the other places carefully to see if efforts are being made to save energy. If possible interview the manager or some other responsible person in the place they are studying to ascertain what is being done to save energy that might not be obvious to an observer.

Ask each team to give a short oral report to the class on their findings. Does it appear that most homemakers and establishments are cooperating with the request to conserve energy? If the answer is no what iedas does the team propose that might get better cooperation?

PURPOSE: To survey community attitudes regarding energy shortages.

LEVEL: 7-9

SUBJECT: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203.

ACTIVITY: Select from the class two or three students who will, with the use of a cassette tape recorder, interview people in the community to ascertain their reaction to the energy situation.

Involve the class in developing questions to be used by the students in the interviews and in deciding on the population to be interviewed.

Questions might include such as the following:

1. In your judgment is there really an energy problem?
2. If there is a problem whose fault is it?
3. If there is a problem what can you do about it?
4. What, if anything, are you doing about it?

The sample of persons to be interviewed should represent a range of ages and occupations such as homemaker, student, store owner, service station operator, trucker, salesman, custodian, and so forth.

Urge the students who are doing the interviews to speak clearly and to urge those being interviewed to do the same since the recording is to be played to the entire class for their study-reaction.

As the recording is played to the class ask students to determine how perceptions of the energy problem differ. Do these perceptions vary according to income level, age, or other criteria? Are there any agreements as to what could/should be done?

The activity might be concluded by asking each student to write a few paragraphs on what he has learned about community attitudes toward the energy problem.

PURPOSE: To examine relationships between life styles and energy costs.

LEVEL: 7-9
10-12

SUBJECT: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy Conservation Teaching Resource Units, Ohio Department of Education.

ACTIVITY: Review with the class the fact that gasoline sells for $1.00 or more per gallon in many European countries such as Switzerland, Holland, Denmark, France, and Great Britain.

Divide the class into groups of three or four students. Ask each group to think about and develop a list of ways in which "life styles" in those countries with high gasoline costs is likely to be different from the ways people live in the U.S.A. where gasoline is cheaper than in any other highly industrialized country. Encourage the groups to think broadly beyond such obvious things as size of automobiles and number of superhighways. Types of family vacations, suburban sprawl, status of railroad passenger service, extent of air travel, use of recreational vehicles and many other elements of our life style can be shown to be related to energy costs.

Ask each group, also, to make value judgments as to whether the life style in high energy cost countries is worse or better than ours. Ask each group to state its conclusion on one or two specific examples and defend its position before the class.

GRADE LEVEL 10 - 12

Activities	
Science	20
Science-Mathematics	3
Science-Social Studies	4
Social Studies	4
Social Studies-Science	1
Social Studies-Language Arts	4

PURPOSE: To determine the effects of gases emitted from the burning of coal in a closed aquatic ecosystem.

LEVEL: 10-12

SUBJECT: Science

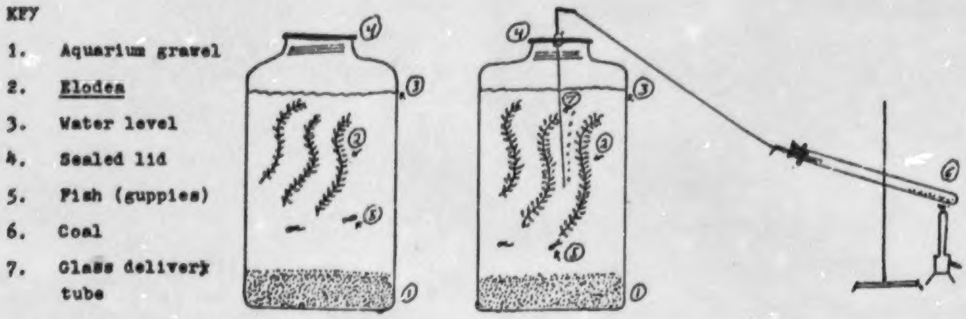
CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Activity suggested by Michele Alexander and John Neth, Science Teachers, Groveport-Madison High School, Groveport, Ohio.

ACTIVITY:* Materials - Elodea, guppies, aquarium sand, glass tubing, rubber tubing and stoppers, 2 one-gallon jars

Into two one-gallon jars add two inches of aquarium gravel. Add water to the top of the vertical column. Add several strands of Anacharis (Elodea sp.). These may be floating or rooted in the gravel. Let the aquaria set for one week. Introduce a male and female guppy. Feed the guppies for several days and then seal the jars with paraffin-coated lids. (The guppies should be fed several times a day.) One jar lid should have a hole large enough to admit a glass tube. Put one gram of finely ground coal with a known sulfur content into a 22 x 180mm test tube. Plug with a one-hole rubber stopper. Insert a short section of glass tubing through the stopper. Place a long (25cm) glass tube through the hole in the lid of one jar. Connect the glass tubes with an aquarium hose. Burn the coal using an external flame. As the coal burns down, be careful that water is not drawn back into the test tube--this could cause the glass to break. Repeat the process daily or weekly for several weeks. Have students record any changes which occur in the two jars. Make sure the jars are kept near each other, under the same conditions, and out of direct sunlight.

What effect does the burning of coal have on this closed aquatic ecosystem? How does this system compare to the biosphere? Does the burning of coal have any potential effect on the aquatic portion of the biosphere? Compare and contrast the effects of burning coal on an aquatic ecosystem and a terrestrial ecosystem.



*The activity should be terminated if it becomes obvious that the fish are being adversely affected.

PURPOSE: To study the effect of siltation and acidity on fresh water life.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Freshwater Ecology, Prentice Hall. Activity suggested by Katherine E. Higgins, Science Teacher, Chaminade-Julienne High School, Dayton, Ohio.

ACTIVITY: After studying the process of coal removal by strip mining, the class will study the possible effects of acid mine drainage and improper soil cover. The class will be divided into four groups. Each group will collect three liters of water sample from the same river, stream or pond into each of two wide-mouth, one-gallon glass jars. All containers should be fairly uniform in the amount of plant material added. The eight jars should be loosely capped and returned to the laboratory where they are placed in indirect light and caps are removed. Four of the jars (A-D) will be aerated to simulate river and stream conditions while the other four will remain stagnant. Jars A and E will have 1 ml. of 1M H_2SO_4 added daily; jars B and F will have 5 grams of soil added daily; jars C and G will have both 1 ml of 1M H_2SO_4 and 5 grams of soil added daily; and jars D and H will be the controls. Beginning the following day and then at least weekly for four to six weeks, each group will test two jars for the following:

1. pH (with a pH meter or pHydrion paper)
2. turbidity (with a Hach kit)
3. color
4. odor
5. dissolved oxygen (Hach kit)
6. dominant plant types
7. dominant animal types

Water evaporating from the jars will be replaced by collected rain water. At the end of the experiment the students should answer the following questions:

1. Were the physical factors of the water samples changed with the addition of acid or soil?

2. How did the addition of acidity or silt affect the succession of plant and animals?

3. Which factor caused the most change? Why?

4. What could be done to reduce the effects of the addition of acid and/or soil to fresh water?

PURPOSE: To examine the effects of acid mine drainage upon the biotic environment.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Activity suggested by Kathleen Pausic Gagen, Science Teacher

ACTIVITY: Background: Runoff water from strip mine areas may be (and often is) very acidic.

Assemble the following materials:

- test tubes
- water
- pH paper
- elodea sprigs
- HCl solution, dilute
- NaOH solution, dilute

Have students work in groups of four to complete the following experiment. Fill each of 12 test tubes with an equal amount of water. Adjust the pH of the water by adding HCl or NaOH to achieve the following pH:

Tube	pH	Tube	pH	Tube	pH
1	2.0	5	4.0	9	6.0
2	2.5	6	4.5	10	6.5
3	3.0	7	5.0	11	7.0
4	3.5	8	5.5	12	7.5

Add a sprig of elodea to each test tube. Place test tubes in rack and place on a window ledge. Examine daily. Record any changes in color, size, or shape of the elodea. Rate the health of the elodea on a scale of zero-five. After one week to ten days determine at what pH death occurs.

SAMPLE DATA TABLE

	1	2	3	4	5	6	7	8	9	10	11	12	tube
date	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	pH

Key: 0 = dead, 5 = healthy

Each student will complete a lab report on the activity. This report will include the following items:

Purpose (in the student's own words)
Materials
Procedure
Data
Discussion
Conclusion

Discuss the following items with the class:

What appears to be the pH at which elodea grown best?
At what pH did the elodea die?
What is acid mine drainage?
Compare the pH at which the elodea can no longer live to the pH of water near strip mines. What would you suppose would be the effect of acid water (from stripped areas) upon the local vegetation?
How can acid mine drainage be minimized or eliminated?

PURPOSE: To study the harmful effects of sulfur dioxide emissions from the burning of fossil fuels.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: *Science Teacher*, Volume 39, Number 9, December 1972, pp 42-44. Weaver, Albert C. *Scientific Experiments in Environmental Pollution.* Vollmer, Gerald W. *Environmental Chemistry in the Secondary School.* Activity suggested by Kenneth McCall, Science Teacher, Portsmouth High School, Portsmouth, Ohio.

ACTIVITY: Ignite some soft coal (high sulfur content if possible) and have students note the odor (using the correct technique). What are the possible gases given off during this reaction? In the hood ignite a piece of pure sulfur, note the odor, collect the gas given off and pass through containers that have the following: red and blue litmus, green leaf, piece of zinc, small piece of colored cloth, and a piece of red apple peel. Be sure and close containers as soon as gas is added. Have students record their results.

Add 10 ml. of water to each container and shake. Again have students record their results.

DISCUSS THE FOLLOWING REACTIONS WITH STUDENTS

When sulfur burns in the air you have the following reaction: $S + O_2 \rightarrow SO_2$.

The sulfur dioxide produced from this reaction added to water yields sulfurous acid. $SO_2 + H_2O \rightarrow H_2SO_3$.

Sulfur dioxide when mixed with oxygen of the air in the presence of sunlight will yield sulfur trioxide. $2SO_2 + O_2 \rightarrow 2SO_3$.

Sulfur trioxide in the presence of water yields sulfuric acid. $SO_3 + H_2O \rightarrow H_2SO_4$.

QUESTIONS

1. Are the bleaching effects due to the dry sulfur dioxide or the sulfurous acid?

2. Why does the paint often peel and blacken on houses located near factories that burn sulfur-containing fuels?

3. For what purpose is powdered sulfur sometimes used on rosebushes?

4. How many useful and essential uses can you list for sulfur and its related compounds?

PURPOSE: To understand the role of energy in American agriculture.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: Since 1930 the yields of most major crops grown on farms in the United States have increased from 200 to 400 percent. During this time the number of farm workers has been reduced several times. What has been responsible for this changing condition? Factors cited most often include the following:

1. Increasing use of machinery

2. Much heavier use of nitrogen and other fertilizers

3. Better seeds

4. Use of herbicides and insecticides

5. Improved transportation.

Ask students to select one or two of the factors and research the extent to which the factor is related to energy sources such as petroleum, natural gas, or electricity. Particular effort should be made to secure information about the increased use of nitrogen fertilizers made from natural gas feed stock.

After collecting data engage the class in discussing the relationships that exist between the cost of oil and natural gas and the cost of grains produced on American farms. Is it likely that our farming methods must change as oil and gas supplies are depleted? What types of changes are possible?

PURPOSE: To determine the half-life of Iodine 131.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Fox, Charles H. Radioactive Wastes, Energy Research and Development Administration, Washington, DC. Activity suggested by Clara Cook, Roosevelt Junior High School, Urbana, Ohio.

ACTIVITY: The activity described could be initiated at the completion of a unit on a nuclear reactor in which there have been discussions, films, etc. on nuclear fission and the by-products thereof.

Place a bottle containing ten microcuries of iodine 131 on the base of a ringstand. Suspend the tube of a Geiger counter several inches above the bottle. As you will want to use the bottle and Geiger tube in this position for several weeks, mark their positions carefully. Remove the stopper from the bottle of iodine 131 and take a count with the Geiger counter for one minute. Read the number of counts per minute. (Be sure to check the background count each day and subtract it from the total count.) Repeat the procedure at the same time each day for several weeks.

Plot the results, using counts per minute as the vertical axis and time in days as the horizontal axis.

Determine the half-life of iodine 131 from the graph.

Would the half-life be different if you used iodine 131 that had just been produced in a nuclear reactor? Why or why not? Would it be possible to determine the half-life of iodine 127?

Does iodine 131 have any practical application?

PURPOSE: To observe and determine solar thermal radiation relative to area, transmission, and reflection.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: *Solar Energy: Energy Research & Development Administration Science Activities*, Dec/Jan 1974. Activity suggested by Dean Lewis, Science Teacher, Eastmoor High School, Columbus, Ohio.

ACTIVITY: Develop with the class the idea that lens and concave mirrors can be used to concentrate thermal solar energy to be "collected" in a calorimeter. Divide the class into six groups with the following assignments:

Group A: The students will use a fresnel lens and focus the radiation into a calorimeter observing the cross sectional area of the lens, time of exposure, and mass of the calorimeter and water, and change in temperature of the water.

Group B: The students will use a glass lens and make observations and use apparatus as in Group A.

Group C: The students will use a differing cross sectional lens than group B making similar procedures and observations.

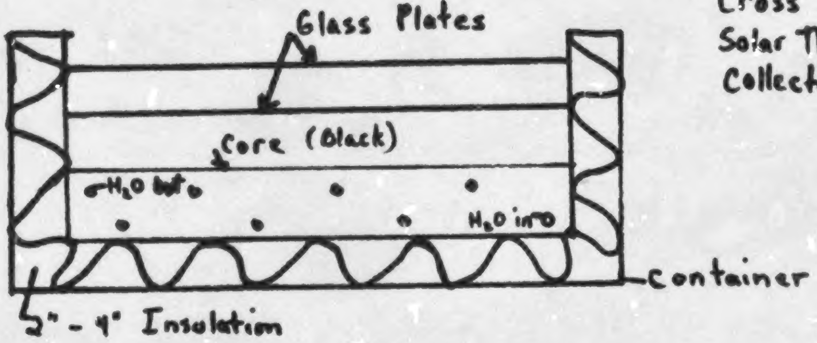
Group D: The students will use a concave mirror with similar observations, apparatus, and procedures as Group A.

Group E: The students will use a differing cross sectional mirror than in Group D.

Group F: Using a container similar to that indicated with an old auto radiator or coils from a refrigerating unit as a core, determine mass of metal core and contained water, and cross sectional area of core exposed to the solar radiation. Measure temperature change and time of exposure to radiation.

Each group is to determine energy/unit time and compare their results with the other groups. Is solar energy a partial answer to our energy needs? Based on your observations, why is this true?

Cross Section of
Solar Thermal
Collector



PURPOSE: To demonstrate the principle involved in removing solid particles from the gaseous emissions of fossil fuel power plants.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Andrews, William A., Editor. A Guide to the Study of Environmental Pollution, Prentice-Hall Inc., 1972. Activity suggested by James M. Richmond, Doctoral Student in Science Education, Ohio State University, Columbus, Ohio.

ACTIVITY: Electric precipitators are now widely used to prevent particulate wastes (fly ash) from being released to the atmosphers through smoke-stacks. Charged particles, ranging in size from 0.1 microns to more than 200 microns, are attracted to electrodes of opposite charge. In this way as much as 99.9% of the particulate emissions can be removed from the gaseous effluent.

MATERIALS

500 ml graduated cylinder
Metal ring stand rod
1-hole rubber stopper
Copper wire
Induction Coil
D.C. power source
Glass tubing
Millipore hand vacuum assembly
Rubber tubing
Cigarette

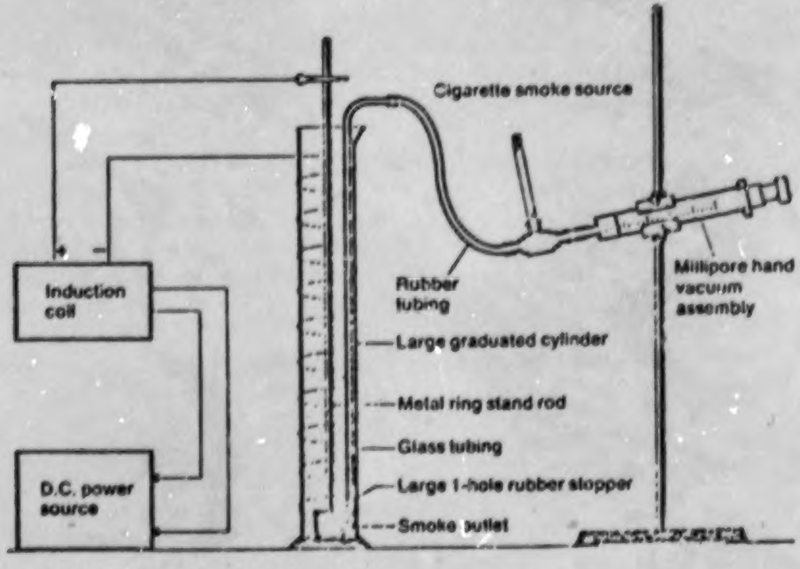
PROCEDURE

Assemble the apparatus as shown in the figure and light the cigarette. Introduce smoke into the bottom of the graduated cylinder by depressing the plunger in the Millipore hand vacuum assembly. When the smoke has diffused to the top of the cylinder, connect the induction coil and switch on the power. Observe the effects of the electric charge on the smoke particles in the cylinder.

Repeat the above procedure using different sources of smoke (e.g. camphor, incense, ammonium chloride). Also introduce the smoke from these various sources at different rates and observe the outcome.

DISCUSSION

Does the efficiency of the model electrostatic precipitator vary noticeably when the nature of the smoke or the rate of smoke production is altered? In addition to fossil fuel power plants, name some industries where this device might be used. Are there any industries in your community that have electrostatic precipitators in their smoke-stacks? If so, find out their cost of installation and their efficiency in removing particulate matter. What are some of the environmental consequences that might be expected if electrostatic precipitators are not used in a heavily industrialized area?



Model of an electrostatic precipitator

PURPOSE: To demonstrate the detection of radioactivity on a photographic plate.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Eckert, T. E., Lyons, H. K., Strevell, W. H. *Discovery Problems in Chemistry*, CEBCO/Standard Publishing, New York, 1972.

ACTIVITY: This activity can be done as a demonstration. Materials needed are a strip of X-ray film or high-speed film, a lightproof envelope, a radioactive source, and a small metal object.

Tape the small metal object to photographic film in a lightproof envelope. On top of the metal object, place a source of radioactivity. Let the preparation remain undisturbed for at least two days. Develop the film in the normal manner and then examine it for evidences of radioactivity. What effect did the metal object have upon the radiation?

Discuss radiation emissions.

PURPOSE: To become aware of products formed by destructive distillation of fuels.

LEVEL: 10-12

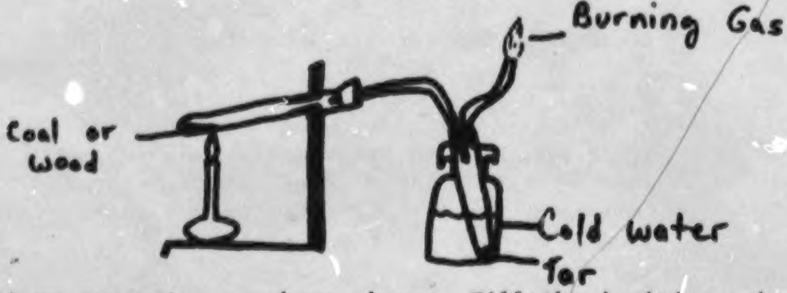
SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Eckert, T. E., Lyons, H. K., Strevell, W. H. Discovery Problems in Chemistry, CEBCO/Standard Publishing New York, 1972.

ACTIVITY: Destructive distillation.

Materials needed: 100 mm Pyrex ignition test tube, glass jet tube, red and blue litmus paper, lead acetate paper, sawdust or wood shavings, powdered soft coal.



Set up apparatus as shown above. Fill the ignition tube about 2/3 full of sawdust, excelsior, or small bits of wood. Heat the tube gently at first and slowly increase the size of the flame until the tube is being heated strongly. Test the escaping gas for hydrogen sulfide by holding a strip of moistened lead acetate paper in it for a few seconds. Bring a flame to the gas escaping through the jet. Note the appearance and odor of the liquid formed in the bottom of the condenser. Test the condensate with red and blue litmus. When there is no further evidence of action, stop heating the tube and allow the apparatus to cool. Remove the contents of the tube and examine the product.

Clean the ignition tube used above as well as you can without using water, and fill it about half full of crushed soft coal. Replace the condenser and tubes with a clean set and heat the coal as you did the wood. Test the escaping gas with lead acetate paper. Test this gas with litmus paper also.

Bring a burning match to the gas escaping from the jet. Heat the tube until gas is no longer given off. Note the appearance and odor of the liquid formed in the bottom of the condenser. Test the liquid with red and blue litmus paper. When the tube has cooled, remove the contents and examine the product.

PURPOSE: To stimulate interest in the idea of producing power directly from the sun.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Jacobson, David. "A Five Dollar Physics Experiment", Science Activities, September 1973.

ACTIVITY: Development of this experiment began with observations of the unusual behavior of metallic booms of the early earth satellites. From the study of "thermal flutters" caused by heat expansion of metals, a small thermal engine was developed. This machine utilizes only a 6-foot long, 3/4-inch diameter aluminum tube and a fly-wheel at its center point, with bearings at either end. A very thin coat of flat black paint is added to intensify the absorptive and emissive qualities of the metal. The heat required to operate the engine can be provided by one or two heat lamps, or directly from the sun. It is possible to produce a steady output of less than 1/10 watt when coupled to an efficient generator. This can be done by directing the light source on the tube's upper surface area near the flywheel.

This rotating tube machine is feasible commercially only if small amounts of energy are required, if solar energy will suffice, and if simplicity is a significant factor. However, it can be used in a classroom to stimulate interest in the use of solar energy as an alternative method of energy production.

PURPOSE: To demonstrate the ability of radioactive material to permeate living things.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

ACTIVITY: Obtain radioactive isotopes suitable to use as tracer elements. Introduce the radioactive material to the soil of a plant. Have students determine the radiation by using a Geiger counter. After one hour, have students count the frequency of clicks. (Background radiation should be determined first and then the plant's frequency.) Students should continue to measure the radiation until it approximates background radiation. Have the students keep a record of the frequency of clicks and the duration involved.

A human subject can be used in place of or in addition to the plant experiment. Give the subject a radioactive cocktail (coke, etc.) and wait for a few minutes. Then pass the Geiger counter probe over the body until the radioactive material is located.

Discuss the problems with radiation artificially added to the environment and the sources of that radiation.

PURPOSE:	To demonstrate the use of a Geiger counter to detect and study radioactivity.
LEVEL:	10-12
SUBJECT:	Science
CONCEPT:	Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.
REFERENCE:	Eckert, T. E., Lyons, H. K., Strevell, W. H. Discovery Problems in Chemistry, CEBCO/Standard Publishing, New York, 1972.

ACTIVITY: This activity can be done as a demonstration or in small groups. Remove all sources of radioactivity from the vicinity of the instrument. Place the Geiger counter probe in position on a mounting board and count the occasional "clicks" produced by the instrument. These are caused by the natural radioactivity in the environment and constitute a "background count". Record this count for five one-minute intervals and determine the average. In precise quantitive experiments the background count must be subtracted from the count due to radioactive materials being tested.

With the counter probe in position on the mounting board, place one of the radioactive sources at the opposite end of the board. Record the frequency of the clicks at this position. Move the source slowly toward the probe and record the frequency of clicks at one-half and one-fourth the original distance. How does distance from the source affect intensity of radiation received? Repeat the above procedure with other radioactive sources and compare the differences.

Experiment with the effects of screening by placing a screen between the counter probe and the radioactive source. Try different materials and compare the frequency of clicks.

PURPOSE: To help students understand how a cooling tower works.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Activity suggested by William Graessle, Science Teacher, Urbana High School, Urbana, Ohio.

ACTIVITY: MATERIALS

5-gallon can with its bottom removed and holes in its side
2 pieces of rubber tubing with 2 sprayers attached
A circular structure made up of porous asbestos material
Large plastic collecting basis
Large fan
Thermometer
2 flat metal strips the diameter of the 5-gallon can

PROCEDURE

The students stick the 2 flat metal strips (the diameter of the 5-gallon can) through appropriate holes in the 5-gallon can forming a +.

The circular structure made of asbestos is pushed down the 5-gallon can to rest on top of the 2 metal strips.

The 5-gallon can is placed on the edges of the plastic basin.

A faucet is turned on that releases hot water. The faucet is allowed to run for awhile. Some hot water is then collected in a beaker and its temperature is taken. Turn off the water. A rubber tube with sprayer is then hooked up to the hot water faucet. The plastic container with the 5-gallon can on top of it is placed close to the faucet. The rubber tubing is run through a hole in the 5-gallon can set up so that hot water will spray over the curcular structure made of asbestos.

The large fan is set on top of the 5-gallon can in such a way that it is blowing air upward and sucking air from the 5-gallon can. Turn on the water. Wait awhile and then record the temperature of the water in the plastic basin.

QUESTIONS

Is the water in the plastic container cooler than the water that is coming out of the hot water faucet? How much?
Is the cooling tower working?

PURPOSE: To demonstrate the construction and use of a solar collector.

LEVEL: 10-12

SUBJECT: Science

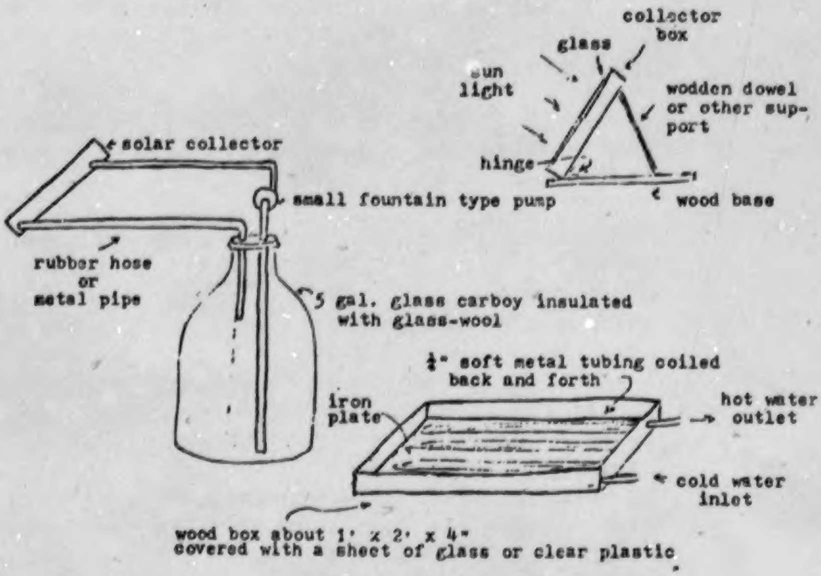
CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However, there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Activity suggested by Jack Romig, Science Teacher, Seven Hills School, Cincinnati, Ohio.

ACTIVITY: Each of the following are outlines for suggested student projects in solar power. The outlines are intended to serve as starting points only and are not to be taken as a set of step-by-step instructions on how to build r design solar collectors.

ACTIVITY 1

Construction of simple solar collector:


collector box
glass
sun light
wodden dowel or other support
hinge
wood base
solar collector
small fountain type pump
rubber hose or metal pipe
5 gal. glass carboy insulated with glass-wool
¼" soft metal tubing coiled back and forth
iron plate
hot water outlet
cold water inlet
wood box about 1' x 2' x 4" covered with a sheet of glass or clear plastic

Construct wooden box, place iron plate with tubing secured on surface inside, paint flat black, cover with glass and place on roof.

Water lines running from roof to classroom should be insulated. Soft rubber sheathing used by air-conditioner contractors should be ideal.

Pump should have a small flow rate but develop enough pressure to push water up to roof. Depending on climate, anti-freeze may be added to prevent bursting pipes in winter.

Recirculate water during daylight only and take temperature readings several times per day over a period of a few weeks. Determine maximum temperature reading.

ACTIVITY 2

Prepare three essentially identical collector systems and vary the tilt referenced to horizontal. Set one collector so measure of angle is equal to latitude above equator. Vary the other collectors and determine the most efficient placement for your geographic location.

ACTIVITY 3

Use three identical collector systems set at optimum angle. Connect the three heat reservoirs in series with each other. Determine if placing the collectors in series or parallel will be more efficient. Propose an explanation for your results.

ACTIVITY 4

To get more realistic results, place a load on your system by drawing off a small quantity of the hot water and make it up with cold. A flow rate of about .1 total volume per hour would be a reasonable load. Determine power rating of system by measuring flow rate and average temperature change. If possible collect data over several months.

ACTIVITY 5

To make the system more efficient, design and install a control device to detect the temperature increase in the collector and interconnect with the pump. The system should circulate water when there is a heat gain in the coil and shut off when not.

ACTIVITY 6

If small experimental system begins to operate effectively, design a larger model using a discarded hot water heater as the tank. Try to use the hot water produced for as manv useful purposes as possible. Some examples are: hot water for washing glassware, design a heat exchange and use the heat to warm aquariums, use the heat to warm animal rooms, plant rooms, or greenhouses.

PURPOSE: To understand the importance of petroleum and natural gas as chemical raw materials.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

ACTIVITY: Request two or three students to do encyclopedic research to ascertain the tremendous number of products being made today that use petroleum and/or natural gas as a basic natural resource material. The list, which could be illustrated in an effective bulletin board display, would include such things as lacquer, varnish, paint thinner, soap, mineral oil, salves, ointments, candles, detergents, waxes, asphalt, pitch, rubber, plastics, synthetic fibers, explosives, fertilizers, and many, many other important industrial chemicals.

The Shah of Iran has indicated that petroleum and natural gas are so critically important as "chemical stock" for the future that it is a very serious mistake to use these substances simply as fuel.

Ask the students who did the research suggested above to lead a class discussion focused on the idea advanced by the Shah. What responsibility, if any, does the present generation have for future ones?

If we reduce the use of petroleum and natural gas for fuel what substitutes might be or are available? What other actions are possible?

PURPOSE: To demonstrate the transfer of energy from a food chain to the environment.

LEVEL: 10-12

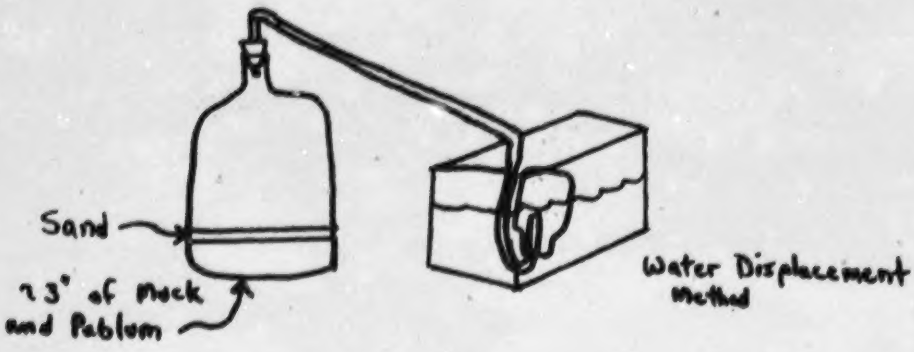
SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Environmental Pollution, Prentice-Hall. Activity suggested by Katherine E. Higgins, Science Teacher, Chaminade-Julienne High School, Dayton, Ohio.

ACTIVITY: After studying food chains and food webs and the flow of energy through the environment the following demonstration of gas production by anaerobic organisms may be demonstrated. A small-mouthed glass is filled with two to three inches of a mixture of muck from the bottom of a stagnant pond and oatmeal pablum in a 5:1 ratio respectively. A thin layer of sand is spread over this and the entire mixture is moistened. The jar is capped with a one-holed stopper and a piece of tubing is connected from the jar to a gas collection apparatus. The gas is then analyzed several days later. Then students should correlate the production of gas in this fashion to the production of natural gas which they use in their homes.

Gas Collection Apparatus



PURPOSE To measure the amount of radioactivity in a collected air sample.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Vollmer, Gerald W. Environmental Chemistry in Secondary School, 1974. Carey, Walter. Experiment on Radioactivity at Stone Laboratory. Activity suggested by Kenneth McCall, Science Teacher, Portsmouth High School, Portsmouth, Ohio.

ACTIVITY: Entire class will take information from a single demonstration following the procedure below. Fill in the data sheet provided with the experiment, do all the calculations and complete the questions at the end of the experiment.

The apparatus needed for this experiment will include a vacuum cleaner, Geiger counter and a means of measuring the air flow. (Note: students are to be involved in figuring out this technique.) The yield of a Geiger counter equals the counts per minute divided by the disintegrations per minute. For most Geiger counters it is approximately 4%. Additional information needed: One Currie equals 3.7 x 10^{10} dps.

DATA TABLE

Rate of air flow .... ________ cu ft/min

Time air flow started .... ________ hrs

Time air flow ended .... ________ hrs

Volume of air used (computed) .... ________ cu ft

Counts per min (computed) .... ________ cpm
  Beginning time ..... ______ hrs
  Ending time .... ______ hrs
  Total count .... ______ minus background

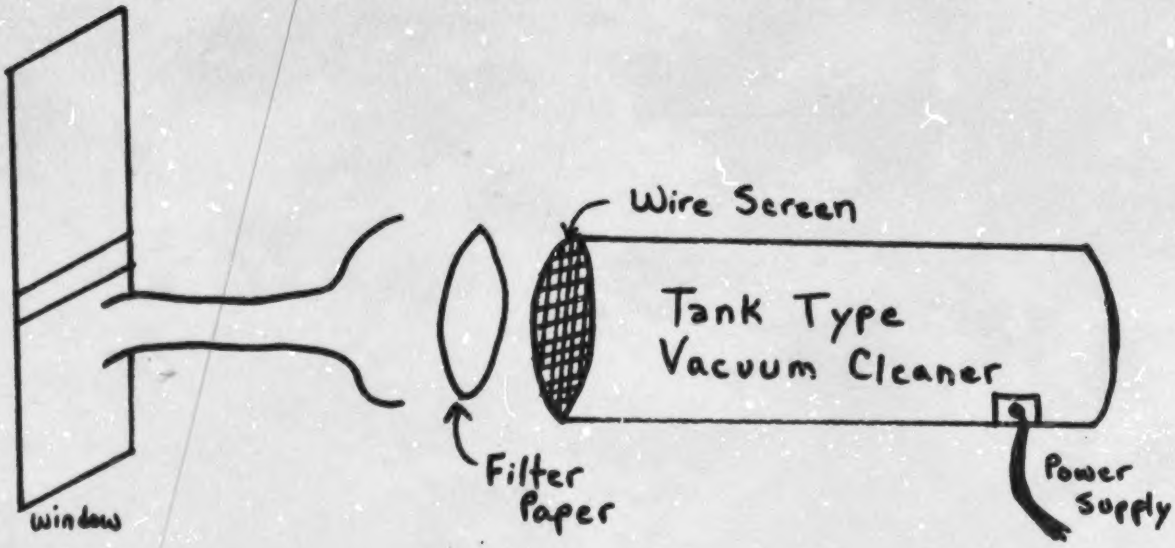
Disintegrations per sec (computed) .... ________ dps
  (_____ cpm ÷ _____ yield) ÷ 60

Change dps to Micro Curries .... ________ uCi
  (one Ci equals 3.7 x 10^{10} dps)

Concentration of Micro Curries/cu ft ..... ________ uCi/cu ft

Concentration of Micro Curries/ml .... ________ uCi/ml

Accepted Value (EPA) .... ________ uCi/ml



PROCEDURE

1. Replace the cleaner bag of a tank-type vacuum cleaner with a wire screen cut to fit in the bag chamber to support a sheet of filter paper.

2. Insert the filter paper against the screen.

3. Replace the cap to which the hose is attached.

4. Place the intake end of the hose through an open window.

5. Start the vacuum cleaner and let it run for one hour, two hours, etc.

6. Remove the filter peper after each "running time" and expose it to the probe of a Geiger counter. Make sure the background count was determined before making each initial measurement.

7. Store the filter and repeat step 6 at different intervals of time in order to measure decay of the natural radioactivity. This material has a very short life and after about 24 hours should almost completely disappear from the sample. At the end of the 24-hour period the reading is more representative of fallout, which has a relatively long life, than is the initial reading.

QUESTIONS

1. What effect do you think the following would have on radioactive fallout: wind direction, wind speed, temperature and general weather conditions?

2. If you observed a day-by-day variation in radioactivity, can you explain this variation?

3. Can you explain the significance of social problems to radioactive fallout?

PURPOSE: To review the Second Law of Thermodynamics by means of an energy anacrostic.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Activity suggested by Yvonne Mather, Science Teacher, Canfield High School, Canfield, Ohio

ACTIVITY:

You Can't Win for Losing

Activity: An Energy Anacrostic
Use: "Filler" during a learning plateau; review; day before vacation; a "gimmick".
Timing: After the energy unit!

"You can't win for losing" is an everyday statement of an important phenomenon in nature - so important that this statement has the status of a LAW. To find out the formal and "official" name of this law, work out the anacrostic.

And then:

1. Look up this LAW in some appropriate reference. Which one? That's your problem; but you might try your notes on energy production.

2. Copy this LAW onto a sheet of paper and show by giving examples (be specific, please) that you understand what it means.

3. Do you believe that the title of this exercise is appropriate? Why? Why not? Be specific - that means EXAMPLES. Prove your whys and why nots.

4. What do you think of this as another possible title?

> "There is no such thing as a free lunch"
> -Barry Commoner

Attach your material from this activity to the completed anacrostic and turn everything in at the end of the period.

YOU CAN'T WIN FOR LOSING

1 2 3 4 5 6   7 8 9   10 11

12 13 14 15 16 17 18 19 20 21 22 23 24 25

1. The ability to do work — 2 20 14 15 ___ ___

2. A commonly used fossil fuel — 3 10 21 7

3. Power source for the atom — 5 ___ 24 ___ ___ 8 ___

4. Useful energy in the home — ___ ___ ___ ___ ___ ___ ___ ___ -
23 12 19

5. Class of materials which are burned — 11 ___ ___ ___ 25

6. This changes to steam in power production — 9 ___ ___ ___ ___

7. The Arabs have this energy source — 4 ___ ___

8. This is too much! Heat pollution — 12 13 ___ 15 16 ___ ___

9. An old, old fuel is described this way — ___ 17 25 ___ ___ ___

10. These are checking stations (one type) — 22 ___ ___ 23 ___ ___ ___

11. This fella made an engine a long, long time ago (steam type) — 13 ___ ___ ___

12. This is the cover for the fuel in the nuclear reactor — ___ ___ ___ 6 18 ___ ___ ___

YOU CAN'T WIN FOR LOSING

S	E	C	O	N	D	L	A	W	O	F
1	2	3	4	5	6	7	8	9	10	11

T	H	E	R	M	O	D	Y	N	A	M	I	C	S
12	13	14	15	16	17	18	19	20	21	22	23	24	25

1. The ability to do work

E	N	E	R	G	Y
2	20	14	15		

2. A commonly used fossil fuel

C	O	A	L
3	10	21	7

3. Power source for the atom

N	U	C	L	E	A	R
5		24			8	

4. Useful energy in the home

E	L	E	C	T	R	I	C-		
							I	T	Y
							23	12	19

5. Class of materials which are burned

F	U	E	L	S
11				25

6. This changes to steam in power production

W	A	T	E	R
9				

7. The Arabs have this energy source

O	I	L
4		

8. This is too much! Heat pollution

T	H	E	R	M	A	L
12	13		15	16		

9. An old, old fuel is described this way

F	O	S	S	I	L
	17	25			

10. These are checking stations (one type)

M	O	N	I	T	O	R
22			23			

11. This fella made an engine a long, long time ago (steam type)

H	E	R	O
13			

12. This is the cover for the fuel in the nuclear reactor

C	L	A	D	D	I	N	G
			6	18			

PURPOSE: To determine the effects of gases emitted from the burning of coal in a closed terrestrial ecosystem.

LEVEL: 10-12

SUBJECT: Science

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Activity suggested by Michele Alexander and John Neth, Science Teachers, Groveport-Madison High School, Groveport, Ohio.

ACTIVITY: Materials - sand, potting soil, coal
two species of plants (two of each)
test tube, 22 X 180mm
glass tubing
hypodermic needle
two one-gallon clear-glass jars with
wide mouths and lids

Into two one-gallon jars, add sufficient pea gravel to a depth of one inch. Making sure the soil is free from fungi, add a minimum of 1 and 1/2 inches of soil. Plant two species of a succulent variety in each jar. Make sure specimens in the two jars are as similar in size and vigor as possible. Drill a hole in the lid and insert a thin rubber diaphragm such as the plugs used in blood-collecting vacuum tubes. As an added protection against unwanted contaminants, use a paraffin seal between the lid and the jar. Add sufficient water to moisten the soil. Screw on the lids and place in indirect sunlight. (Direct sunlight will cook the plants.) Keep both jars together and allow the jars to reach equalibrium.

Finally, grind one gram of high sulfur coal (or coal used in your area). Place the coal in a large test tube. Insert a small glass tube into a one-hole stopper. Connect the rubber tubing to the protruding glass tube. Then insert the entire apparatus into the end of the test tube. To the end of the rubber tubing attach a hypodermic needle of sufficient size and length. Insert the needle into the diaphragm, making sure the opening is not blocked.

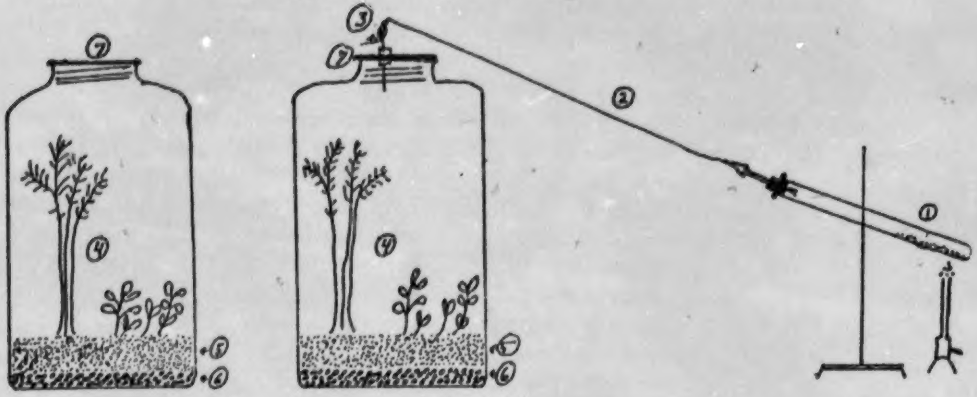
Heat the test tube containing the coal until all the coal has burned.

Observe the growth rates of the plants in each jar. Daily measurements should be taken. The gases from the coal should be administered daily for two weeks.

What effects did the burning of the coal have on the closed ecosystem? Explain.

How does this closed ecosystem compare with our biosphere?

Based on the data collected on this experiment, what do you think could be some of the possible effects of burning coal in our atmosphere?



KEY

1. Test tube containing finely ground coal
2. Rubber tubing
3. Hypodermic needle through rubber diaphragm
4. Succulent plants
5. Disease-free potting soil
6. Pea gravel
7. Sealed jar lids

PURPOSE: To determine water's heat of condensation experimentally.

LEVEL: 10-12

SUBJECT: Science
Mathematics

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Activity suggested by Wayne R. Flint, Science Teacher, Streetsboro High School, Streetsboro, Ohio.

ACTIVITY: It takes 180 calories of heat to raise the temperature of 1.0 gram of ice from it's melting point of 0°C to its boiling point of 100°C. To convert that boiling water to steam which is also at 100°C requires an additional 540 calories of heat. Thus the heat needed to convert boiling water into steam at the same temperature is about three times greater than the heat needed to convert melting ice into boiling water.

The 540 calories per gram value of evaporation and condensation of water may be determined experimentally in the following manner:

Twist two 16-18 inch lengths of 1/4-inch copper tubing into the forms shown in figures A & B. Drill several 1/16-inch holes in the bottom of the coiled section of coil B. Fit rubber stoppers over the ends of the copper coils and plug them into the ends of a pipe tee. Fit a 0°-150°C thermometer with a rubber stopper and plug it into the side of the pipe tee. Fasten the tee to a support stand.

Pour a measured weight of water of known temperature into the jug and seal it up temporarily. Fill the pressure cooker about half full of water and bring it to a boil on a hot plate. When the boiling starts, connect a rubber hose to the pressure gage vent and to coil A. Next, set a small burner under coil A to super heat the steam to about 110°C. After a minute or two there will be super heated steam blowing out of coil B.

Now remove the lid from the jug and place coil B near the bottom of the water. The steam will quickly raise the temperature of the water so after a few minutes disconnect coil B from the pipe tee and record the maximum temperature reached by the water. Finally, reweigh the water in the jug to see how many grams of steam were added to it.

The heat of steam condensation can now be calculated as is shown in the following illustration.

Starting temperature of the steam and coil B......... 110°C
Starting temperature of the water in the jug......... 10°C
Maximum temperature reached by the water............. 40°C
Weight of the water..................................1070 g
Weight of coil B..................................... 100 g
Weight of the steam added............................ 50 g

Temperature rise of the cold water.........40° - 10° = 30°C
Heat gain of the water (1070 g) (30° rise)
(1.0 cal. per gram per degree rise)..........= 32,100 Cal.

Temperature lost by coil B and the steam..110° - 40° - 70°C

Heat lost by coil B (100 g) (70° lost) (0.1 cal.
per gram per degree lost).......................= 700 Cal.

Heat lost by steam cooling from 110° to 100° (50 g)
(10° lost) (0.5 cal. per gram per degree).......= 250 Cal.

Heat lost by water cooling from 100° to 40° (50 g)
(70° lost) (1.0 cal. per gram per degree)......= 3500 Cal.

Heat lost by the steam condensing into water must be the heat still not accounted for; therefore:

Cal. lost by the steam = 32,100 cal. - (700 cal. + 250 cal. +
3500 cal.).......................= 27,650 Cal. lost by steam

Since it took 50 g of condensing steam to lose 27,650 cal., the amount lost by each gram would be:

$$\frac{27{,}650\text{ cal.}}{50\text{ g steam}} = 553\text{ cal/g as the heat of condensation}$$

$$\text{Experimental error: } \frac{[(553\text{ cal.}) - (540\text{ cal.})]\quad(100\%)}{540\text{ cal.}} = 2.4\%$$

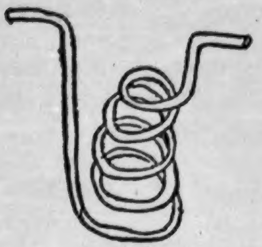


Figure A

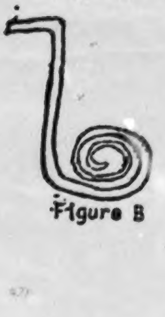


Figure B

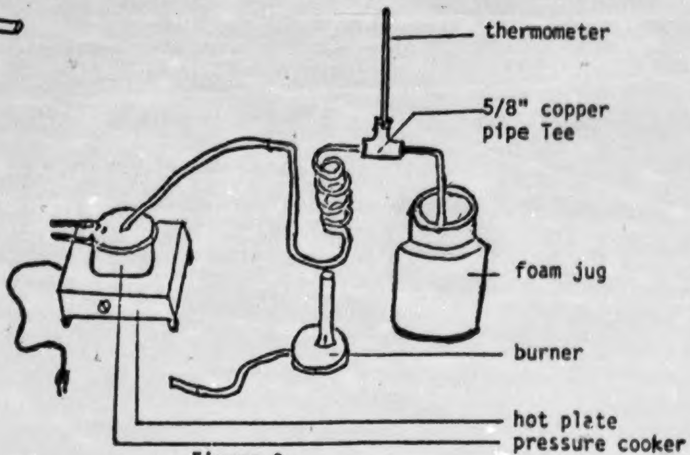


Figure C

PURPOSE: To determine the heat content of fuel gases experimentally.

LEVEL: 10-12

SUBJECT: Science
Mathematics

CONCEPT: Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.

REFERENCE: Activity suggested by Wayne R. Flint, Science Teacher, Streetsboro High School, Streetsboro, Ohio

ACTIVITY: Fuels such as natural gas and propane have a definite quantity of chemically bound energy that can be converted into a definite corresponding amount of heat energy. This exercise can be used to determine how much energy natural gas, propane, or an alcohol has. It can also determine whether or not yellow flames produce as much heat as blue flames.

Use water displacement to determine the number of seconds needed to pass exactly one liter of methane through a bunsen burner or to pass one liter of propane through a propane torch.

System one: Place the burner inside a large, inverted, water-filled jug. Measure the number of seconds needed for enough gas to pass through the burner to empty the water from the jug.

System two: Remove the barrel from the burner and use a rubber hose to transfer the gas to an inverted, water-filled jug. Measure the number of seconds needed for enough gas to pass through the burner to empty the water from the jug.

For either system, divide the jug's volume in liters into the number of seconds of elapsed time to obtain the time needed for one liter of flow. The calculations needed for the Boyle's law, Charles' Law and water's vapor pressure may be included at this point for advanced classes.

Construct calorimeters by covering the top and sides of two liter pans with several layers of damp asbestos furnace paper. Cut the asbestos so that it extends about 20 cm below the bottom of the pans. Set the pans aside and allow the asbestos to dry, then mount the pans on ring stands so that the asbestos skirt reaches down to about 10 cm above the table top.

To operate the calorimeter, add 1,000 grams of cool water to the pan. Next, light the burner and set it inside the asbestos skirt under the pan for the number of seconds it takes for 1.0 liters of gas to pass through it. Record the maximum temperature reached by the water in the pan.

The calculation for the heat content of the gas is:

$$\text{Kilocalories/liter of gas} = \left[(\text{Kg water}) + (0.22)(\text{Kg aluminum pan})\right] \times (\text{temp. rise C}^{\circ})$$

This experiment should be repeated using two or more different fuels with the burner adjusted each time to burn with a hot blue flame. Then it should be repeated again with the burner's air supply reduced so that the fuels burn with a cool yellow flame.

PURPOSE: To determine the energy required to transport students to school.

LEVEL: 10-12

SUBJECT: Science
Mathematics

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Activity suggested by Michele Alexander and John Neth, Science Teachers, Groveport-Madison High School, Groveport, Ohio.

ACTIVITY: Review with students general concepts in the natural production of fossil fuels. Direct the discussion to petroleum specifically. Have students determine what volume of crude oil is necessary for the production of a gallon of gasoline.

Discuss with the students the need for transportation. Have students list the various modes of transportation. Direct student discussion to school bus transportation.

Have a student call the school bus garage to find out the number of buses operating at the high school. Also find out the miles driven by the buses per day and the average number of miles per gallon. Calculate the number of gallons of gas consumed by the buses per year.

Have several students count the number of student cars in the parking lot. Calculate the average number of miles driven by students to and from school.

1. Calculate the gallons of gas per student (annually) if all the students rode buses.
2. Calculate the gallons of gas per student (annually) including both gas consumed by buses and by student drivers.

Students should then break up into small groups to determine the most efficient mode of transportation. They should discuss reasons why the most efficient method is or is not used.

1. If the most efficient consumption of fuel is not being used, what impact is this on local social standing and on environmental damage?
2. What suggestions do you have for more efficient use of this fossil fuel?
3. In the event of another fuel shortage, what could be done by students to conserve fuel?

PURPOSE: To understand that energy must be invested to produce energy.

LEVEL: 10-12

SUBJECT: Science
Social Studies

CONCEPT: Energy is so basic that nothing moves or is accomplished without it.

ACTIVITY: Within the next few years the United States will be getting large amounts of petroleum from Alaskan oil fields. Before any of this energy comes out of the fields, however, huge amounts of energy must be put into the development.

Ask students working in groups of three or four, to list energy inputs into the Alaska oil field development. With little difficulty they should cite energy users such as bulldozers to grade roads, energy needed to make bulldozers, energy needed to make pipe, to transport pipe, to lay pipe, energy needed to heat living quarters, and many others. Encourage the groups to make their lists as comprehensive as possible.

Pool the group prepared lists to get a general feeling for the enormity of the energy investment. Is oil from Alaska likely to cost more than oil from Texas or Saudi Arabia? Why or why not? Is it likely that all or most of the world's "cheap oil" has been found? Is it likely that Americans will ever pay $1.00 or more for a gallon of gasoline? What can be done to reduce this likelihood?

PURPOSE: To predict the location of coal beds from topographical maps.

LEVEL: 10-12

SUBJECT: Science
Social Studies

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: Activity suggested by Wayne R. Flint, Science Teacher, Streetsboro High School, Streetsboro, Ohio.

ACTIVITY: Many minerals such as coal and limestone occur in distinct layers called beds. These beds usually cover many square kilometers (sq.mi.) and usually are tilted or bent downward in one direction. Once strip mining has started at several points on a single bed of mineral, it is easy to plot the outline of the bed and predict its mass and volume from a topographical map.

First: Have student teams make a topographical cross section of an area which has several strip mines scattered across it. This is accomplished by drawing a straight line across a topographical map then plotting on graph paper each of the contour lines that touch the straight line.

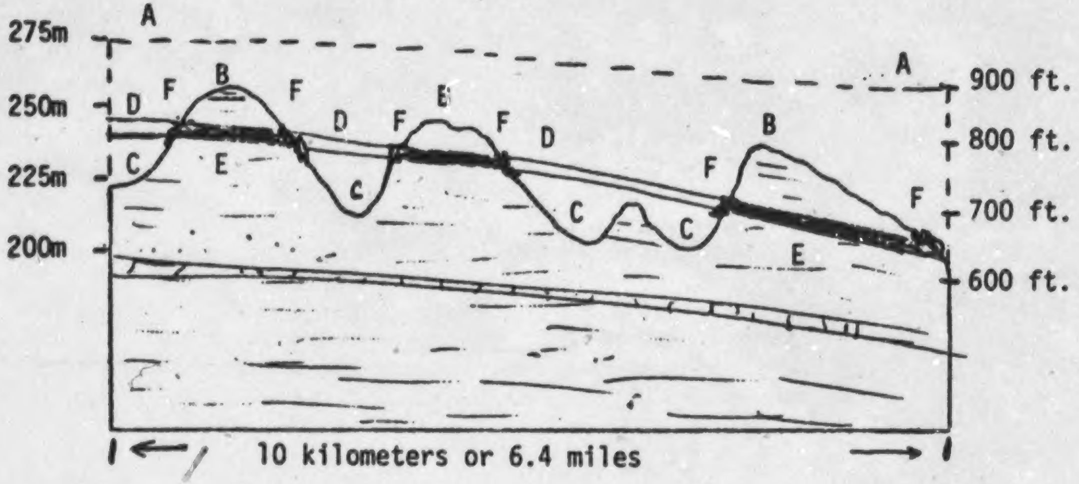
Second: Have the students mark on the completed cross sectional plots the locations of each strip mine that touches the line drawn on the map. Since coal (and other minerals) occur in beds, the students can sketch the location of the hidden coal bed by connecting the elevations of the strip-mined areas.

Third: The amount of tilt (dip or strike) in the bed can be readily determined by examination of the graphed data.

Fourth: If the mined area is located close to the school, the approximate volume of coal present in the bed can be estimated. Measure the bed's thickness at road cuts and on the mine high walls. Next, multiply the surface area of the bed times its thickness times the specific gravity of the coal.

TEACHING NOTES: The teacher must check the map carefully in advance of this exercise to make sure only one mineral is being strip mined in the map area being studied. Otherwise the students will usually unknowingly plot both mine systems on one paper and get a set of data they cannot interpret.

The finished cross sectional diagram should look like the one shown below.



LEGEND:
A - Land surface before erosion started
B - Present hilltops
C - Present valleys
D - Coal bed removed by erosion
E - Remaining coal bed
F - Strip mined areas

PURPOSE: To confront students with the problem of making energy-related value decisions.

LEVEL: 10-12

SUBJECT: Science
Social Studies

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Activity suggested by Michele Alexander and John Neth, Science Teachers, Groveport-Madison High School, Groveport, Ohio.

ACTIVITY: Students are arranged into groups of four. Each student is given a copy of the case study and several related questions. As a group they are to discuss the problems involved and try to come to a group decision.

CASE STUDY

Area: Along the Ohio River, in an area called the Big Bend.

Location: A 350 acre farm.

History: The people living in the area are direct descendents from the original owner, a Southern plantation master. The area was once a thriving plantation located along the banks of the river. Today, a single women resides on the farm in question. She is the granddaughter of the original owner. The current owner cares little for the farming way of life, but has a religious reverence for the land of her forefathers. Recently, she learned that less than 400 feet down on her land there is a four-foot seam of coal. In addition, natural gas has been found on her farm. She has agreed to allow the gas to be pumped out but no gas has been removed to date. Not only that, but various individuals in the gas company have reputedly asked for secrecy concerning her wells.

Beyond this, a large electric company is considering buying her farm as a site for a nuclear power plant. In attempting to purchase the farm, the electric company reputedly claimed no knowledge of the coal seam. Currently, the owner does not want to sell. If she refuses, the state will condemn her land, buy it and sell it to the power company.

QUESTIONS

Does an individual have the right to refuse to sell his/her land? Does a power company have a responsibility to be completely frank with potential land purchases? Should land be used for "national need" as opposed to "personal need"? If you were a power company president would you take the ancestral home from a 75-year-old widow? Should a power company own land which it does not intend to build a plant on?

PURPOSE: To gain some insight into the problems of power plant siting.

LEVEL: 10-12

SUBJECT: Science
Social Studies

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Ris, Thomas F., Editor. Energy and Man's Environment: Elementary Through Secondary Interdisciplinary Activity Guide, Education/Research Systems, Inc., 2121 Fifth Avenue, Seattle, Washington 98121. Activity suggested by Lilian Winnenberg, Science Teacher, Miller High School, Hemlock, Ohio.

ACTIVITY: Give students topographical maps of any area. The maps may be obtained from the State Department of Natural Resources or from a county engineer. Tell students they are to choose a site in the area of the map for the possible location of a power generating plant.

Help students formulate a number of factors they must know before making a decision about the site. What are the advantages or disadvantages of the topography? What fuel is readily available? What is the population of the area? Is the population increasing or decreasing? What are the industrial demands for electricity? Is there a need for the plant? What fuel is available in the area? Cost of the fuel? Modes of transportation available? Can existing transmission lines be used? Will there be disposal problems in the area?

What are some of the other considerations that go into the siting of a utility that relate to the plant itself? Will the plant size continue to serve the needs of the area over a period of time? What jobs will be displaced or created during plant construction? What are the pollutants of the plant? What are the laws of the area regarding the type of pollutants? Governmental laws? Can the plant system design meet the regulatory environmental laws? Cost?

Have the students write to their congressman for a copy of the Power Siting Law in their state. In Ohio ask for Chapter 4906. Ohio Revised Code.

Ask a representative of the power company serving your area to talk to the students about power plant siting.

The student will read each "siting" problem. Then under the "jurisdiction" columns place one of the following codes to indicate which agency should have jurisdiction for each problem.

0 = no jurisdiction
1 = primary (major) jurisdiction
2 = secondary (minor) jurisdiction
C = coordinate with, as a means of information, but not as a policy determiner.

Give reasons for the choices. Include the economic, transportation, environmental and social factors.

PROBLEMS OF SITING	JURISDICTIONS				
	Regional or local	State	Federal	Private	Other
INDUSTRIAL COMPLEX					
"HEAVY INDUSTRY"					
"LIGHT INDUSTRY"					
FOSSIL POWER PLANT					
NUCLEAR POWER PLANT					
MINERAL MINES					
OIL WELLS					
NEW CITY					
PORT					
STRIP MINES					
GRAVEL PIT					

PURPOSE: To consider the world-wide scope of nuclear power problems.

LEVEL: 10-12

SUBJECT: Social Studies

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

ACTIVITY: Ralph Nader supported by some scientists argues strongly against building more nuclear power generating stations in the United States. His arguments often center on the danger of radioactivity that could be released by a catastrophic accident to the nuclear reactor container and also the possibility that terrorists might be able to steal radioactive materials and fashion an A-bomb to use as they desire.

In considering these and other questions related to the desirability of building more nuclear power plants students should be informed that such plants are operating in many countries other than the U.S.A. Japan, Canada, West Germany, France, Great Britain, Italy, Spain, Switzerland, India, U.S.S.R. and China are presently producing electricity with nuclear power. Other countries such as Brazil have contracted with countries other than the U.S.A. to have nuclear power plants built and operating within the next few years.

Does the U.S. have any control over the growth of such plants in other countries? Should we be concerned about such developments? If nuclear power is unsatisfactory what alternatives are better? What is being done to expedite these alternatives?

PURPOSE: To examine the concept of "lead time" in developing energy resources.

LEVEL: 10-12

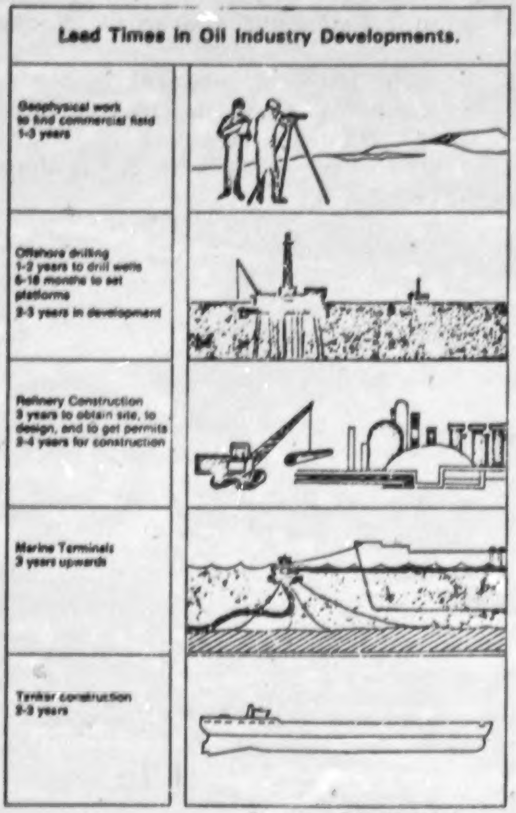
SUBJECT: Social Studies

CONCEPT: Presently, most of our energy requirements are met thru using fossil fuels. However there are other alternative sources of energy such as solar, wind, fission, fusion, hydrogen, hydro, and geothermal which must be considered and developed.

REFERENCE: A Teacher's Handbook on Energy, Colorado Department of Education, Denver, Colorado 80203.

ACTIVITY: In discussing with the class the idea of the U.S.A. becoming more independent in petroleum supplies, introduce, with a transparency made from the drawing below, the concept of "lead time". Emphasize that in the oil industry planners must think in terms of several years, not just a few months.

Suggest that individuals or small groups of students could earn extra credit by researching why the lead times are so long and reporting their findings by bulletin board display, short talk, or written report.


Lead Times in Oil Industry Developments.
Geophysical work to find commercial field 1-3 years
Offshore drilling 1-2 years to drill wells 6-18 months to set platforms 2-3 years in development
Refinery Construction 3 years to obtain site, to design, and to get permits 2-4 years for construction
Marine Terminals 3 years upwards
Tanker construction 2-3 years

Courtesy of Shell Oil Company

PURPOSE: To show the process by which trade-offs may be made between energy production and environmental control.

LEVEL: 10-12

SUBJECT: Social Studies

CONCEPT: The production and distribution of energy have environmental and economic consequences.

REFERENCE: Rocks, L.; Runyon, R. The Energy Crisis, Crown Publishing Company, New York. Activity suggested by Katherine E. Higgins, Science Teacher, Chaminade-Julienne High School, Dayton, Ohio.

ACTIVITY: Show a graph of "U.S. Gas Demands Exceed Supply" such as that found on page 28 of the book The Energy Crisis. Have the students list as many alternative sources of energy as they know of. Then set the following hypothetical situation: natural gas is an irreplaceable resource necessary for the maintenance of our technological society. Use the following scenario: "It is the year 2000. You are in your forties and your life expectancy is now ninety due to the radical reduction of pollution from transportation and electricity production. Natural gas is essential for the manufacturing of pollution-free transportation, and for that reason it is only used in this manner. Research is being conducted for an alternative energy source, but it is predicted that this will take at least twenty years. In the meantime, we have used almost all our known reserves and other countries refuse to sell us any. Our last known large reserve could last an estimated twenty-five years, but it is located in the central part of the 7,000 acre reservation of the Julichamin Indians in Southern Ohio. The tribe has gone to court several times to protect their land since it is a part of their religious culture, and to destroy or tamper with it would be in violation of their beliefs. In the early 1970's, President Nixon granted them all rights to this land for eternity. They rely on horses and their feet for transportation, so they have no use for vehicles. However, if the U.S. does not get a supply of gas for the next twenty years, it is feared that there will be a collapse in the quality of life, a decreased life expectancy and an economic depression. A hearing is set up to discuss all sides of the issue".

SIMULATION

Divide the class in the following manner:

1. Two representatives from the Bureau of Indian Affairs
2. Two representatives from ERDA
3. Two representatives from the gas production industry

4. Two representatives from the Sierra Club

5. Two representatives from the transportation industry

6. One arbitrator (may be the teacher)

7. The Indian tribe. There should be a five-person council and the remaining class members may choose to play different roles in the tribe.

The class should be given adequate time to research their positions on the problem. They should research such topics as tribal customs, religious customs of primitive societies, treaty rights, past relations of Indians with the Bureau of Indian affairs, dependence of the American economy on transportation, the effects of the combustion engine on human health. The students may choose to costume themselves to fit their roles in the hearing.

After the hearing all students should answer these questions:

1. Which do you feel is more important - the Indians' rights to maintain their society or the needs of the U.S. technological society?

2. How important is energy in our society? What would you suggest to do if we ran short and another country had lots left?

3. Would you lower your standard of living or quality of life to preserve another culture?

PURPOSE: To examine the importance of energy in a specific vocational field.

LEVEL: 7-9
10-12

SUBJECT: Social Studies

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: The Energy Book, South Carolina Department of Education, Columbia, South Carolina.

ACTIVITY: During a social studies unit on choosing a vocation or at some other appropriate time ask students, working alone or in pairs, to develop a notebook on an occupation of their choice.

Specify that in addition to availability of work in the vocational field, salary potential, education required, special training needed and so forth special attention be given to the energy requirements associated with their vocational choice. How would their vocation be affected if special forms of energy such as natural gas would be curtailed drastically? What would be the effect if gasoline prices doubled? If electricity became much more expensive?

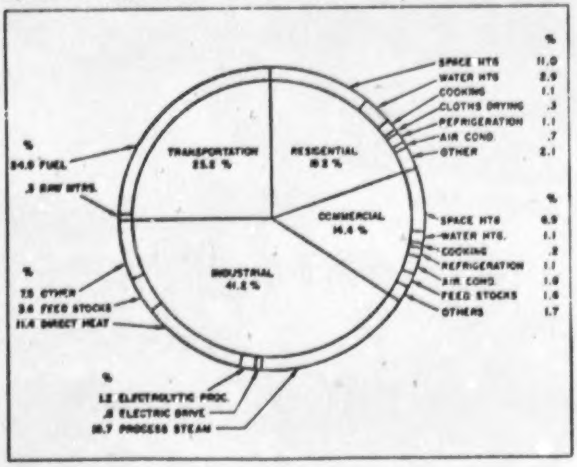
Ask that students consider also the ecological impact of their occupation on local community, state, nation, and the world. Is the occupation likely to have a positive, neutral, or negative effect?

PURPOSE:	To understand more fully the pattern of energy usage in the United States.
LEVEL:	7-9 10-12
SUBJECT:	Social Studies Science
CONCEPT:	Energy is a fixed commodity being neither created nor destroyed but converted from one form to another. The means of conversion and the by-products of this conversion are important.
REFERENCE:	Fowler, J. M.; Mervine, K. E. Energy and the Environment, ESSO Education Foundation.
ACTIVITY:	Present to the class the figure shown below. Ask students working in groups of two or three to (1) identify out of their own personal experience or previous knowledge the energy sources (oil, gas, coal, etc.) used for various purposes shown such as space heating, water heating, cooking, and so forth, and (2) give two examples of how energy could be saved in each of the use categories shown.

Each group should present its conclusions in chart form to a reporting committee of four students who will analyze the data and report conclusions the following day regarding residential, commercial, industrial, and transportation energy consumption. (The person reporting on industrial uses should augment what comes from the class by contacting an industrial, chemical, or mechanical engineer for ideas and examples pertinent to that area.)

In summary discussion raise questions about what each class member can do that can make a difference in each of the major categories.

Figure 4. U.S. energy consumption 1971 (total 60.5 x 10^{15} BTUs).



PURPOSE: To examine relationships between life styles and energy costs.

LEVEL:
7-9
10-12

SUBJECT:
Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy Conservation Teaching Resource Units, Ohio Department of Education.

ACTIVITY: Review with the class the fact that gasoline sells for $1.00 or more per gallon in many European countries such as Switzerland, Holland, Denmark, France, and Great Britain.

Divide the class into groups of three or four students. Ask each group to think about and develop a list of ways in which "life styles" in those countries with high gasoline costs is likely to be different from the ways people live in the U.S.A. where gasoline is cheaper than in any other highly industrialized country. Encourage the groups to think broadly beyond such obvious things as size of automobiles and number of superhighways. Types of family vacations, suburban sprawl, status of railroad passenger service, extent of air travel, use of recreational vehicles and many other elements of our life style can be shown to be related to energy costs.

Ask each group, also, to make value judgments as to whether the life style in high energy cost countries is worse or better than ours. Ask each group to state its conclusion on one or two specific examples and defend its position before the class.

PURPOSE: To examine problems related to pricing electricity.

LEVEL: 10-12

SUBJECT: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Fulton, William L., Editor. The Farkleberry Cookbook In Environmental Education, Arkansas Department of Education, Little Rock, Arkansas 72201. SE 018 629.

ACTIVITY: In recent months many communities have become concerned with the increasing costs of electricity. Many persons are upset with rate schedules built on the principle that as one uses additional power, the cost per unit of power goes down. Thus, the more power you use, the cheaper it is in terms of unit cost. If utility bills include a local tax on the cost of electricity the heavy user also pays less tax per unit of power used than does the average or frugal user.

Suggest to the class that it assume the role of a State Public Service Commission or Public Utility Commission that will hold a hearing to consider changing electric rates for a community that has been protesting the present rate structure. Citizens appear to be concerned with the "fairness" of the present rates and the environmental results that occur. They think that people using more of our non-renewable resources ought to pay for this and the resulting pollution. On the other hand, the town officials say they want to attract new companies, and the power company says it is less expensive to serve large customers - so the rates are fair.

Select several students to make presentations to the commission from different points of view such as homemaker, president of power company, Sierra Club member, factory owner, factory worker, Chamber of Commerce spokesman, Salvation Army spokes man.

After the presentations ask the class to decide by vote the changes, if any, that should be made in the electric rate structure. Ask the presenters if they felt they could truly represent the person or group they spoke for. To whom should that responsibility be given? What type of person should serve on the State Public Utility Commission?

PURPOSE: To examine attitudes toward lowered speed limits.

LEVEL: 10-12

SUBJECT: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

ACTIVITY: Speed requires energy. Most automobiles operate much more efficiently at 50 MPH than at 70 MPH. As an energy conservation measure the U.S. government in 1973 lowered the speed limit on the interstate highway system from 65 to 55 MPH. Daily experience of persons driving along the interstate system verifies that the 55 MPH limit is violated by enormous numbers of drivers. An increasing use of citizen band radios by truck drivers and some motorists appears to be a deliberate attempt to foil the police in their efforts to enforce the lowered speed limits.

Ask each member of the class to interview two or three licensed drivers with a series of questions such as: How seriously do you regard the 55 MPH limit? How seriously, in your judgment, do other drivers appear to regard it? Do you think it was a good idea to try to slow down traffic to save energy? Do you think it is o.k. to use the CB radios to "beat the police"?

Pool and discuss findings in a class setting. Share conclusions in a class developed "letter to the editor."

PURPOSE: To consider the desirability of reducing energy used for recreational purposes.

LEVEL: 10-12

SUBJECT: Social Studies
Language Arts

CONCEPT: Energy, its production, use, and conservation are essential in the maintenance of our society as we know it.

REFERENCE: Energy Conservation Teaching Resource Units, Ohio Department of Education.

ACTIVITY: Review with the class the general idea that recreational activities consume tremendous amounts of energy in the United States. Involve the class in listing some of the biggest users such as night baseball games, the Indianapolis 500 automobile race, air-conditioned playing areas such as the Superdome, Monday night football on TV, and others.

Organize the class to simulate a Senate sub-committee charged with investigating the desirability of outlawing or drastically reducing high energy use recreational activies such as those cited above.

Urge students to prepare and read short written statements in support of or in opposition to the idea under investigation. A "committee" of three to five students should be given opportunity to question the witnesses after their presentations.

After hearing all testimony the committee should prepare the recommendations it will submit to the Senate (entire class) on this issue. The report should include the major considerations that shaped the judgment of the committee.

The committee report should be made available in written or oral form to the entire class which, after study and review, votes to accept or reject the sub-committee recommendations.